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PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 20 February 2001 (20.02.01)	
International application No. PCT/AU00/00808	**Applicant's or agent's file reference** 28634WOP00
International filing date (day/month/year) 05 July 2000 (05.07.00)	**Priority date** (day/month/year) 06 July 1999 (06.07.99)
Applicant CHICK, Steve	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

22 January 2001 (22.01.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

R. E. Stoffel

Telephone No.: (41-22) 338.83.38

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00808

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: G10D 3/16, G10H 3/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: G10D 3/--, G10H 3/--

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT: G10D003/IC, G10H003/IC, plectrum OR pick, conduct+ OR contact+, signal+ OR trigger+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US-4235144-A (LUBOW et al.) 25 November 1980 See references 18, 18', 18", and 18"' throughout the document.	30
A		1 to 29, 31 to 43
A	US-5864083-A (CAREN) 26 January 1999	1 to 43
A	US-5698808-A (HAMLIN) 16 December 1997	1 to 43
A	US-5300730-A (EKHAUS) 5 April 1994	1 to 43

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 August 2000	22 AUG 2000

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
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ISA/AU

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU00/00808

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member
US	4235144	NIL
US	5864083	NIL
US	5698808	NIL
US	5300730	NIL

END OF ANNEX

5

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 28634wo	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. **PCT/AU00/00808**	International Filing Date *(day/month/year)* 5 July 2000	Priority Date *(day/month/year)* 6 July 1999

International Patent Classification (IPC) or national classification and IPC

Int. Cl. [7] G10D 3/16, G10H 3/18

Applicant

STEVE CHICK RESEARCH PTY LTD et al

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

[X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 7 sheet(s).

3. This report contains indications relating to the following items:

I	[X]	Basis of the report
II	[ ]	Priority
III	[ ]	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	[ ]	Lack of unity of invention
V	[X]	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	[ ]	Certain documents cited
VII	[ ]	Certain defects in the international application
VIII	[ ]	Certain observations on the international application

Date of submission of the demand	Date of completion of the report
22 January 2001	21 March 2001
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **MICHAEL HARDY** Telephone No. (02) 6283 2547

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
T/AU00/00808

I. Basis of the report

1. With regard to the **elements** of the international application:*

- [ ] the international application as originally filed.
- [X] the description, pages **1 to 3, 5, 7 to 9, and 14 to 16**, as originally filed,
  pages **6, 10, 11, 12, and 13,** filed with the demand,
  pages **4,** received on **13 March 2001** with the letter of **13 March 2001**
- [X] the claims, pages **17 to 20, and 22 to 24,** as originally filed,
  pages , as amended (together with any statement) under Article 19,
  pages , filed with the demand,
  pages **21,** received on **13 March 2001** with the letter of **13 March 2001**
- [X] the drawings, pages **1/10 to 10/10,** as originally filed,
  pages , filed with the demand,
  pages , received on with the letter of
- [ ] the sequence listing part of the description:
  pages , as originally filed
  pages , filed with the demand
  pages , received on with the letter of

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

- [ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- [ ] the language of publication of the international application (under Rule 48.3(b)).
- [ ] the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, was on the basis of the sequence listing:

- [ ] contained in the international application in written form.
- [ ] filed together with the international application in computer readable form.
- [ ] furnished subsequently to this Authority in written form.
- [ ] furnished subsequently to this Authority in computer readable form.
- [ ] The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- [ ] The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. [ ] The amendments have resulted in the cancellation of:
   - [ ] the description, pages
   - [ ] the claims, Nos.
   - [ ] the drawings, sheets/fig.

5. [ ] This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims **1 to 43**	**YES**
	Claims	**NO**
Inventive step (IS)	Claims **1 to 43**	**YES**
	Claims	**NO**
Industrial applicability (IA)	Claims **1 to 43**	**YES**
	Claims	**NO**

2. Citations and explanations (Rule 70.7)

D1: US-4235144-A (LUBOW et al.) 25 November 1980

D2: US-5864083-A (CAREN) 26 January 1999

D3: US-5698808-A (HAMLIN) 16 December 1997

D4: US-5300730-A (EKHAUS) 5 April 1994

Documents D1 to D4 are all concerned with electric stringed instruments in which a plectrum or pick has been adapted into an active element for producing signals that are used to control or effect the musical signal output from the instrument. In documents D1 and D3 the pick includes conductive portions and is electrically connected to monitoring circuitry which detects when the conductive portion has contacted a string of the instrument. In D2 and D4 the pick includes force sensors or strain gauges which produce signals indicative of the force of contact between the pick and the strings of the instrument.

Claim 1 defines a plectrum for a string instrument which includes a non-conductive body and "...a conductive tip protruding just beyond an edge of said plucking portion, *an outer surface of said tip being sized so as to fleetingly contact a string of said instrument...*". This design of the conductive tip differs markedly from the plectrums of D1 and D3 in which a relatively large proportion of the plectrum is used to make electrical contact with the strings of the instrument. This difference improves the performance of the plectrum by reducing the instances of false triggering as discussed on page 2.

Because all claims depend from the novel and inventive claim 1, claims 2 to 43 are novel and involve an inventive step also.

[AMENDED PAGE]

Preferably the transmitter is mountable to a person playing the instrument, for example by means of a strap mounted to the wrist of the person. The transmitter is preferably electrically connectable to the plectrum by the second wire.

According to a third aspect of the invention there is provided a transmitter adapted for use with a plectrum as described above, said transmitter having a radio frequency signal generator electrically connectable to said tip such that, when said tip fleetingly connects with said string during plucking, the tip injects a radio frequency signal into the string.

According to a fourth aspect of the invention there is provided a receiver adapted for use with the transmitter as described above including receiver circuitry being tuned to said radio frequency so as to detect the radio frequency signal injected into the string, the receiver being operatively associated with said electronic monitoring circuitry so as to provide said triggering signal.

According to another aspect of the invention there is provided a signal processing apparatus in combination with a string instrument being plucked by the plectrum described above, wherein said signal processing apparatus is adapted to process an audio signal derived from said string instrument, said apparatus including:

a first input to receive said audio signal;

a second input to receive a triggering signal which includes a plurality of triggering pulses, each indicative of a plucking of any of said strings by said plectrum tip;

signal processing circuitry adapted to perform a plurality of different processes, each process modifying the audio signal, said circuitry being electrically connected to said first and second inputs, and wherein said signal processing circuitry is adapted to vary the particular process used to modify the audio signal according to a predefined relationship with said triggering signal; and

Figs. 9a and 9b are circuit diagrams showing circuitry included in a transmitter according to the present invention;

Figs. 10a to 10L are circuit diagrams showing circuitry included in a receiver according to the present invention;

Figs. 11 to 15 inclusive are waveform diagrams showing various signals associated with the transmitter/receiver arrangement of the present invention;

Fig. 16 is a schematic diagram illustrating the transition between various events in a signal processing apparatus according to the invention; and

Fig. 17 is a schematic view of a signal processing apparatus according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS:

Referring to the drawings, the plectrum 4 shown in Figs. 1 to 5 includes a non-conductive body 5 having a gripping portion 6 and a plucking portion 7. The body 5 is constructed of a plastics material in the preferred embodiment. A conductive tip 8 protrudes just beyond an edge 9 of the plucking portion 7. The outer surface of the tip 8 is sized so as to fleetingly contact a string 10 of the instrument 11 as the string 10 is plucked by the plucking portion 7. This is best shown in the progressive plucking action illustrated in Fig. 5. In particular, contact between the tip 8 and the string 10 occurs at step D of Fig. 5. The tip 8 is capable of operative association with electronic monitoring circuitry 12, an embodiment of which is shown in Figs. 10a to 10L. The details of the operative association between the tip 8 and the electronic monitoring circuitry 12 will be described in more detail later in this document. The electronic monitoring circuitry 12 is adapted to provide a triggering signal shown as signal G in Fig. 15 each time the tip 8 contacts any of the strings 10 of the instrument 11.

{AMENDED PAGE}

As illustrated in Fig. 9, the transmitter circuitry of the preferred embodiment makes radio frequency grounding connections labelled RGND or +3V. This may be achieved by allowing one of the terminal connections of the battery to make direct connection with the skin of a user. Such a radio frequency ground connection has been found by the inventor to provide a significantly stronger signal, if such is desired.

The strings 10 of the instrument 11 are electrically connected to an instrument-ground 29, which is, in turn, electrically connected to the receiver 24, and in particular to the receiver circuitry 26. The instrument-ground 29 is normally included as a part of the audio cable.

The radio frequency generator 25 is capable of producing a signal A as shown in Fig. 11. This signal is a waveform at a carrier frequency which preferably lies within the range of 100KHz to 30MHz, and in the preferred embodiment is 3.545MHz.

As best shown in Fig. 6, the instrument-ground 29 is electrically connected to the receiver-ground 30, the connection 31 effectively forming an electrical short between the grounds 29 and 30 at audio frequencies such as those generated by the instrument 11, however the connection 31 also effectively forms a first tuned receiver between the grounds 29 and 30, the tuned receiver being broadly tuned at the carrier frequency. The connection 31 is an inductor (labelled L1 in Fig. 6 and labelled L11 in Fig. 10e) and a capacitor (labelled C1 in Fig. 6 and C26 in Fig. 10e) wired in parallel between the instrument-ground 29 and the receiver-ground 30. The 3.545MHz radio frequency that is coupled into the resonate circuit 31 appears as a voltage at connection 29, this voltage is illustrated in Fig. 12 signal B. Signal B is coupled through the capacitor C27 into the amplifier circuitry 28 which is comprised of Q1, R34, R35, R36, R37 and C23. This 3.545MHz amplified signal is then coupled through C22 onto the base of transistor Q3 which forms a non-linear mixer along with R42, R38, R39, and R43, circuitry 34. A 4.00MHz local oscillator signal is generated from circuitry 33. This circuitry comprises U8,

C57, C58, R73 and X5. Such an arrangement allows the local oscillator frequency to be easily changed by using a different frequency crystal X5, along with a corresponding change to the frequency of the transmitter. Such a change may become necessary if two identical preferred embodiments are operating at close quarters and interfering with each other. The output (U5 pin 2) is coupled onto the emitter of Q3 through the capacitor C34. The resulting Signal C as appears on the collector of Q3 has a frequency component that is equal to the difference between the 3.545MHz carrier frequency and the 4.00MHz local oscillator. This difference is known as the intermediate frequency and in the preferred embodiment is a waveform having a 455KHz component as shown in Fig. 13. The amplitude of the 455KHz frequency component is directly proportional to the amplitude of the 3.545MHz carrier radio frequency. The band pass filter as described next selectively passes only the 455KHz frequency so in effect the circuitry has selectivity for the frequency of 3.545MHz. This helps in the rejection of broad spectrum noise which could potentially interfere with the operation of the device. This technique is known as a superheterodyne receiver. This gives Signal C as shown in Fig. 13. Signal C is then passed through a selective band pass filter 35 tuned at the intermediate frequency. In the preferred embodiment, the selective band pass filter 35 is comprised of a ceramic resonator labelled X2 in Fig. 10f. The output of the selective band pass filter 35 is signal D as shown in Fig. 14. Signal D is present in the electronic monitoring circuit only when the tip 8 of the plectrum 4 is in contact with the string 10. This is shown in Fig. 15 where intermittent bursts of signal D are shown.

The signal is then amplified by Q4 as shown in Fig. 10g. The degree of amplification is varied by potentiometer VR2. This allows the user to adjust the signal strength, which affects the sensitivity of the system to outside interference. If the gain is too low the system may miss triggers, however if it is too high false triggers may be caused by outside electromagnetic interference.

[AMENDED PAGE}

The signal is then passed through a detector circuit 36 which is made up of Q5, R50 & C42 as also shown in Fig. 10g. The output of Q5 is the envelope of the intermediate frequency component which is proportional to the radio frequency signal. This is shown as signal E in Fig. 15. The envelope has brief pulses 37 which substantially correspond to the period of time for which the plectrum tip 8 is in contact with the string 10. This signal is then AC coupled and amplified by U5B as shown in Fig. 10g. The brief pulses 37 are then time-stretched so as to provide a modified signal (signal F shown in Fig. 15) having time-stretched pulses 38 which, because of their longer duration, are not missed by the microprocessor to which the signal is subsequently fed. The time-stretching of the pulses 37 is performed by D15, C45, R54 and R57 as shown in Fig. 10g.

The electronic monitoring circuitry 12 includes a microprocessor 39 adapted to receive said modified signal (signal F) and to perform an analogue-to-digital conversion thereto using U2 so as to produce a digital representation of signal F. The microprocessor 39 is further adapted to detect positive transients 40 in the digital version of the signal and to generate a triggering signal (signal G) by correlating each of the positive transients 40 with an initial contact of the plectrum tip 8 with the string 10. In other words, each time the plectrum tip 8 initially makes conductive contact with the string 10, instantaneously before the moment of plucking, the electronic monitoring circuitry is adapted to output a triggering signal responsive to said contact. The triggering signal (signal G) provided by one preferred embodiment of the invention is of the MIDI (Musical Instrument Digital Interface) type. An alternative embodiment outputs a triggering signal consisting of a control voltage and a gate signal (this alternative triggering signal is not illustrated). The triggering signal is fed from the receiver 24 via triggering cable 41 as shown in Fig. 8.

[AMENDED PAGE}

Put simply, when a transient 40 of sufficient amplitude is detected, a pick event is deemed to have happened and the associated controlled signals are then generated to provide a triggering signal.

The audio signal (not illustrated) generated by the instrument 11 is applied to amplifier U3C via resistor R13 as shown in Fig. 10k. This circuitry 50 is adapted to store maximum amplitudes of the audio signal from the instrument 11. In other words, each time a string 10 of the instrument 11 is plucked, the receiver circuitry stores a maximum amplitude of the resulting audio signal. The circuitry of U3B, U3D, D4, D7 and C15 (as indicated on Figs. 10k and 10L) holds said maximum amplitude. The electronic monitoring circuitry 12 includes a microprocessor 39 (which may be the same microprocessor mentioned previously, or may be a separate microprocessor) which is adapted to measure the stored amplitude and to output a value corresponding to the amplitude. In some embodiments this value is digital and in other embodiments it is analogue. The value is effectively an output corresponding to the force with which the string 10 is plucked. This information can be transmitted to an audio effects system so that effects can respond to the intensity with which a string 10 is plucked. In some embodiments, the electronic monitoring circuitry 12 and the receiver circuitry 50 are adapted to measure and record the maximum amplitude of the audio signal each time the tip 8 contacts a string 10. In other embodiments, circuitry 12 and 50 is adapted to measure the maximum amplitudes occurring during predefined time intervals.

With reference to Fig. 17, the signal processing apparatus 42 processes the audio signal derived from the string instrument 11. In some preferred embodiments all signal processing is performed digitally, in other preferred embodiments the signal processing may be exclusively analogue, or a combination of digital and analogue. The signal processing apparatus 42 is adapted to function in conjunction with the plectrum of the present invention. The apparatus 42 includes a first input 43 to receive the audio

25. A transmitter / receiver arrangement according to claim 24 wherein said microprocessor is further adapted to detect positive transients in said modified signal and to generate said triggering signal by correlating each of said positive transients with an initial contact of the plectrum tip with the string.

26. A transmitter / receiver arrangement according to any one of claims 10 to 25 wherein said receiver circuitry is adapted to store and output a value corresponding to a maximum amplitude of an audio signal from said instrument each time the plectrum contacts the string.

27. A transmitter / receiver arrangement according to claim 26 wherein said electronic monitoring circuitry includes a microprocessor adapted to measure the stored value and to output a digital value corresponding to the amplitude.

28. A transmitter adapted for use with a plectrum as defined in any one of claims 1 to 9, said transmitter having a radio frequency signal generator electrically connectable to said tip such that, when said tip fleetingly connects with said string during plucking, the tip injects a radio frequency signal into the string.

29. A receiver adapted for use with the transmitter as defined in claim 28 including receiver circuitry being tuned to said radio frequency so as to detect the radio frequency signal injected into the string, the receiver being operatively associated with said electronic monitoring circuitry so as to provide said triggering signal.

30. [AMENDED] A signal processing apparatus in combination with a string instrument being plucked by the plectrum defined in any one of claims 1 to 9, wherein said signal processing apparatus is adapted to process an audio signal derived from said string instrument, said apparatus including:

a first input to receive said audio signal;

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

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11 January 2001 (11.01.2001)

PCT

(10) International Publication Number
WO 01/03107 A1

(51) International Patent Classification[7]: G10D 3/16, G10H 3/18

(21) International Application Number: PCT/AU00/00808

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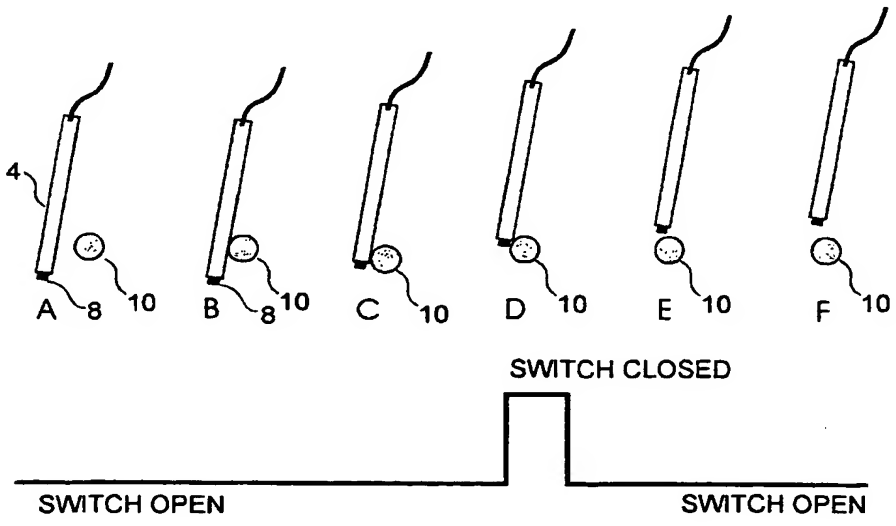
(81) Designated States *(national)*: AU, CA, CN, DE, GB, JP, US.

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A PLECTRUM FOR A STRING INSTRUMENT, A TRANSMITTER/RECEIVER ARRANGEMENT AND A SIGNAL PROCESSING APPARATUS



(57) Abstract: A plectrum (4) for a stringed musical instrument having a plurality of conductive strings (10) is provided with a non-conductive body (5) and a conductive tip (8). The conductive tip (8) is sized so as to fleetingly contact a string (10) when the string is plucked with a plectrum. The tip (8) is electrically connected to monitoring circuitry which provides a triggering signal each time the tip contacts any of the strings (10). A transmitter and receiver arrangement is provided to monitor the contact of the tip (8) with the strings (10) and generate the triggering signal. The triggering signal is in turn received by a signal processing apparatus which modifies the audio signal output from the stringed musical instrument under the control of the triggering signal.

WO 01/03107 A1

TITLE: A Plectrum for a String Instrument, A Transmitter/Receiver Arrangement and a Signal Processing Apparatus

FIELD OF THE INVENTION:

The present invention relates to string instruments having a plurality of conductive strings, for example electric guitars. In particular, the present invention relates to a plectrum for use with such string instruments, a transmitter/receiver arrangement adapted for use with the plectrum and a signal processing apparatus also adapted for use with the plectrum.

The invention has been developed primarily for use in digital processing of the audio output from a string instrument and will be described hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to this particular field of use. For example, the triggering signal derived from the present invention can also be used to drive effects other than audio effects, for example lighting effects being synchronised with music played upon the string instrument.

BACKGROUND TO THE INVENTION:

Known techniques for processing an audio signal derived from string instruments are limited by the difficulty of providing an accurate triggering signal to enable event-driven signal processing techniques. Accordingly, most signal processing techniques currently used in real-time with string instruments are continuous in the sense that a signal processing process is not stopped and started on an event basis. Typical audio effect processes such as echo, reverberation, phasing, panning, chorus and flanging are usually continuous in nature since the effect is applied to the audio signal continuously for as long as the effect is desired.

An attempt to provide a triggering signal to enable more sophisticated signal processing is described in US Patent No. 4,235,144. This prior art document discloses a

conductive pick connected to a contact sensor which senses conductive contact between the strings of the guitar and the conductive pick. In this arrangement, breaking contact between the pick and the string initiates a special musical effect.

It has been appreciated by the inventor of the present invention however that this prior art arrangement suffers numerous technical defects to the extent that it cannot be successfully employed to provide a triggering signal reliable enough to enable sophisticated event-driven signal processing. In particular, the inventor of the present invention has discovered that the conductive contact between the string and the prior art conductive pick can be subject to numerous imperfections leading to false triggering. This can be exacerbated by the habit of some string instrument players of resting their pick on the string before actually plucking the string. As the prior art arrangement triggers from the moment when conductive contact between the pick and the string is broken, the imperfect conductive connection can result in false triggering. Other factors leading to imperfect triggering by the prior art arrangement of US Patent No. 4,235,144 include: a string and/or the pick may be tarnished, thereby inhibiting stable conductive contact; the pressure of the pick on the string may not be constant due to the player touching the pick against the string lightly; and larger gauge strings in particular can be vibrating quite vigorously towards and away from the pick, thereby initiating and breaking conductive contact prior to plucking of the string. Whilst this imperfect triggering may suffice for the relatively simple effects outlined in the abovementioned US patent, it has been found by the inventor of the present application not to suffice for slightly more sophisticated triggering such as MIDI triggering, Control Voltage and Gate triggering, in other words, the type of triggering required for the signal processing provided by modern synthesizers.

OBJECT OF THE INVENTION:

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

SUMMARY OF THE INVENTION:

According to a first aspect of the invention there is provided a plectrum for a string instrument having a plurality of conductive strings, said plectrum including:

a non-conductive body defining a gripping portion and a plucking portion; and

a conductive tip protruding just beyond an edge of said plucking portion, an outer surface of said tip being sized so as to fleetingly contact a string of said instrument when said string is plucked by said plucking portion, said tip further being capable of operative association with electronic monitoring circuitry adapted to provide a triggering signal each time the tip contacts any one of said strings.

Preferably the tip is electrically connected to a first wire embedded within the body which is, in turn, electrically connected to a second wire external of the body and extending from a point on the body remote of the plucking portion.

In the preferred embodiment the tip protrudes from an outer edge of the plucking portion by no more than 1mm and the perimeter length of the tip is no greater than 8mm.

According to a second aspect of the invention there is provided a transmitter/receiver arrangement adapted for use with a plectrum as described above, said arrangement including a transmitter having a signal generator electrically connectable to said tip such that, when said tip fleetingly connects with said string during plucking, the transmitter produces a signal which is detectable by receiver circuitry, said receiver circuitry being operatively associated with said electronic monitoring circuitry so as to provide said triggering signal.

Preferably the transmitter is mountable to a person playing the instrument, for example by means of a strap mounted to the wrist of the person. The transmitter is preferably electrically connectable to the plectrum by the second wire.

According to a third aspect of the invention there is provided a transmitter adapted for use with a plectrum as described above, said transmitter having a radio frequency signal generator electrically connectable to said tip such that, when said tip fleetingly connects with said string during plucking, the tip injects a radio frequency signal into the string.

According to a fourth aspect of the invention there is provided a receiver adapted for use with the transmitter as described above including receiver circuitry being tuned to said radio frequency so as to detect the radio frequency signal injected into the string, the receiver being operatively associated with said electronic monitoring circuitry so as to provide said triggering signal.

According to another aspect of the invention there is provided a signal processing apparatus adapted to process an audio signal derived from a string instrument having a plurality of conductive strings being plucked by the plectrum described above, said apparatus including:

a first input to receive said audio signal;

a second input to receive a triggering signal which includes a plurality of triggering pulses, each indicative of a plucking of any of said strings by said plectrum tip;

signal processing circuitry adapted to perform a plurality of different processes, each process modifying the audio signal, said circuitry being electrically connected to said first and second inputs, and wherein said signal processing circuitry is adapted to vary the particular process used to modify the audio signal according to a predefined relationship with said triggering signal; and

an output electrically connected to said signal processing circuitry for outputting a modified audio signal.

In one preferred embodiment the predefined relationship is such that the process is varied each time an integral number of triggering pulses are received. For example, this integral number may be 1, in other words the process applied to the audio signal is varied each time a triggering pulse is received.

BRIEF DESCRIPTION OF THE DRAWINGS:

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a cross-sectional view of a plectrum according to the invention taken through Line 1-1 of Fig. 3;

Fig. 2 is a plan view of the plectrum shown in Fig. 1;

Fig. 2a is an exploded view of the tip shown within the dotted region of Fig. 2;

Fig. 3 is a side view of the plectrum shown in Fig. 1;

Fig. 4 is a plan view of the plectrum shown in Fig. 1, along with a string of an instrument;

Fig. 5 is a progressive view of a plectrum according to the present invention plucking a string on an instrument, along a pulse arising from said plucking action;

Fig. 6 is a schematic view of a transmitter/receiver arrangement according to the present invention and its relationship to a string instrument;

Fig. 7 is a plan view of a transmitter mounted to the wrist of a user, said transmitter being electrically connected to a plectrum according to the invention;

Fig. 8 is a part-perspective, part-schematic view of a receiver according to the present invention, the receiver being electrically connected to a string instrument;

Fig. 9 is a circuit diagram showing circuitry included in a transmitter according to the present invention;

Fig. 10 is a circuit diagram showing circuitry included in a receiver according to the present invention;

Figs. 11 to 15 inclusive are waveform diagrams showing various signals associated with the transmitter/receiver arrangement of the present invention;

Fig. 16 is a schematic diagram illustrating the transition between various events in a signal processing apparatus according to the invention; and

Fig. 17 is a schematic view of a signal processing apparatus according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS:

Referring to the drawings, the plectrum 4 shown in Figs. 1 to 5 includes a non-conductive body 5 having a gripping portion 6 and a plucking portion 7. The body 5 is constructed of a plastics material in the preferred embodiment. A conductive tip 8 protrudes just beyond an edge 9 of the plucking portion 7. The outer surface of the tip 8 is sized so as to fleetingly contact a string 10 of the instrument 11 as the string 10 is plucked by the plucking portion 7. This is best shown in the progressive plucking action illustrated in Fig. 5. In particular, contact between the tip 8 and the string 10 occurs at step D of Fig. 5. The tip 8 is capable of operative association with electronic monitoring circuitry 12, an embodiment of which is shown in Fig. 10. The details of the operative association between the tip 8 and the electronic monitoring circuitry 12 will be described in more detail later in this document. The electronic monitoring circuitry 12 is adapted to provide a triggering signal shown as signal G in Fig. 15 each time the tip 8 contacts any of the strings 10 of the instrument 11.

This inventive arrangement has been found to provide far more reliable triggering than that provided by the prior art. Additionally, because the tip 8 only contacts the string 10 during the instant of plucking, it is possible for the electronic monitoring circuitry 12 to monitor for any moment that conductive contact between the tip 8 and the wire 10 is made, rather than monitoring for the moment when conductive contact is broken, as in the prior art.

The geometry of the non-conductive body 5 and the barely exposed tip 8 is such that a player can rest the plectrum against a string, as shown in views B and C of Fig. 5 prior to plucking without the tip 8 contacting the string 10, and therefore without causing any false triggering. Additionally, as the electronic monitoring circuitry 12 of the preferred embodiment monitors for the instant that conductive contact is made, rather than broken, it is possible for the arrangement of the present invention to provide a triggering signal wherein each triggering pulse is initiated an instantaneous moment before a string 10 is actually plucked. This advantageously effectively provides a lead time which can be offset against any lag time that may exist in the audio signal processing apparatus to help ensure that the audio signal processing apparatus is in a required state prior to, or at the moment of, receiving the audio input resulting from the plucking of the string.

The tip 8 is electrically connected to a first wire 13 which may be embedded within the body 5. In other embodiments (not illustrated), the tip 8 is an integral part of the wire 13. The first wire 13 is, in turn, electrically connected to a second wire 14 external of the body 5. The second wire 14 extends from a point 15 of the body 5 remote of the plucking portion 7.

In one embodiment the first and second wires 13 and 14 are formed from a pre-shrunk polyester (not illustrated) upon which silver conductive ink is screen printed to provide a conductive surface. This advantageously provides a strong conductor which is sufficiently thin to be embedded within the body 5, or applied thereto as a surface coating.

Additionally, the pre-shrunk polyester can be manufactured with a width which can be attached to the plectrum 4 such that the width is aligned with the body 5. This provides ergonomic advantages by contributing to freedom of movement of the plectrum. The width is preferably between 2mm and 8mm, and in the preferred embodiment is approximately 3.5mm.

The tip 8 preferably protrudes from the outer edge 9 of the plucking portion 7 by no more than 1mm. In the preferred embodiment, the distance by which the tip 8 protrudes is 0.5mm. This dimension can be best appreciated with reference to Fig. 3 and in particular to the perpendicular distance separating lines 16 marked thereon. In the preferred embodiment the perimeter length of the tip 8 is no greater than 8mm and the dimension used in the preferred embodiment is 2mm. This dimension can be best appreciated from Fig. 2a, and in particular from the distance separating lines 17 marked thereon. The width of the tip 8 is preferably no greater than the width of the pick and in the preferred embodiment is 0.5mm. This can be best seen with reference to Fig. 3 and in particular to the perpendicular distance separating lines 18 marked thereon. This dimension is less than the corresponding width of the body 5. An outer edge 22 of the tip 8 is shaped to generally correspond to the shape of the outer edge of the plucking region 7 from which the tip 8 extends.

As best shown in Fig. 2, the body 5 of the plectrum 4 is generally a triangular shape. The region adjacent first apex 19 defines the plucking portion 7 and the tip 8 is disposed at the first apex 19. The second wire 14 extends from, or adjacent to, one of the other apexes, in this case, apex 20. In other embodiments, the second wire 14 extends from other regions of the body 5 of the plectrum 4. The region adjacent apexes 20 and 21 defines the gripping portion 6.

The electronic monitoring circuitry 12 is adapted to detect the initiation of conductive contact between the tip 8 and the string 10 and to use said contact as the

basis for the triggering signal. The switch which is effectively formed by the plectrum 4 and the string 10 is shown in an open state in figure 4.

Fig. 6 depicts a schematic representation of the transmitter 23, a receiver 24 and a preferred embodiment of a transmitter/receiver arrangement whereby said transmitter 23 communicates to said receiver 24. The transmitter 23 includes a signal generator 25 which is electrically connectable to the tip 8. In one embodiment, the tip 8 is connected to a radio frequency signal generator 25 via the first and second wires, the second wire terminating in a plug which is mateable with a socket provided upon the transmitter 23. When the tip 8 fleetingly connects with the string 10 during plucking, as shown in Fig. 5, the tip 8 injects a radio frequency signal shown as signal A in Fig. 11 into the string 10. The radio frequency signal (signal A) is detectable by receiver circuitry 26 which is tuned to the signal. The receiver 24 is operatively associated with electronic monitoring circuitry 12 so as to provide the triggering signal (signal G).

In another embodiment (not illustrated), the electrical connection between the tip 8 and the transmitter 23 is achieved by means of capacitive coupling. It will be appreciated by those skilled in the art that other methods of electrical connection may also be used.

In the illustrated preferred embodiment the transmitter 23 is mountable to a person 27 playing the instrument 11. In particular, the transmitter 23 is disposed upon, or housed within, a strap 28 mountable to a wrist of the person 27. The strap of the preferred embodiment is held in place by hook and eye fasteners (also known as "velcro"), although clearly other fastening means may be employed. The strap 28 includes means to house or mount a battery (not illustrated) to power the radio frequency signal generator 25. This allows the player 27 of the instrument 11 greater freedom of movement as compared to having the plectrum 4 hard wired to circuitry win the receiver which would require a long cable from the plectrum to the receiver.

As illustrated in Fig. 9, the transmitter circuitry of the preferred embodiment makes radio frequency grounding connections labelled RGND or +3V. This may be achieved by allowing one of the terminal connections of the battery to make direct connection with the skin of a user. Such a radio frequency ground connection has been found by the inventor to provide a significantly stronger signal, if such is desired.

The strings 10 of the instrument 11 are electrically connected to an instrument-ground 29, which is, in turn, electrically connected to the receiver 24, and in particular to the receiver circuitry 26. The instrument-ground 29 is normally included as a part of the audio cable.

The radio frequency generator 25 is capable of producing a signal A as shown in Fig. 11. This signal is a waveform at a carrier frequency which preferably lies within the range of 100KHz to 30MHz, and in the preferred embodiment is 3.545MHz.

As best shown in Fig. 6, the instrument-ground 29 is electrically connected to the receiver-ground 30, the connection 31 effectively forming an electrical short between the grounds 29 and 30 at audio frequencies such as those generated by the instrument 11, however the connection 31 also effectively forms a first tuned receiver between the grounds 29 and 30, the tuned receiver being broadly tuned at the carrier frequency. The connection 31 is an inductor (labelled L1 in Fig. 6 and labelled L11 in Fig. 10) and a capacitor (labelled C1 in Fig. 6 and C26 in Fig. 10) wired in parallel between the instrument-ground 29 and the receiver-ground 30. The 3.545MHz radio frequency that is coupled into the resonate circuit 31 appears as a voltage at connection 29, this voltage is illustrated in Fig. 12 signal B. Signal B is coupled through the capacitor C27 into the amplifier circuitry 28 which is comprised of Q1, R34, R35, R36, R37 and C23. This 3.545MHz amplified signal is then coupled through C22 onto the base of transistor Q3 which forms a non-linear mixer along with R42, R38, R39, and R43, circuitry 34. A 4.00MHz local oscillator signal is generated from circuitry 33. This circuitry comprises U8,

C57, C58, R73 and X5. Such an arrangement allows the local oscillator frequency to be easily changed by using a different frequency crystal X5, along with a corresponding change to the frequency of the transmitter. Such a change may become necessary if two identical preferred embodiments are operating at close quarters and interfering with each other. The output (U5 pin 2) is coupled onto the emitter of Q3 through the capacitor C34. The resulting Signal C as appears on the collector of Q3 has a frequency component that is equal to the difference between the 3.545MHz carrier frequency and the 4.00MHz local oscillator. This difference is known as the intermediate frequency and in the preferred embodiment is a waveform having a 455KHz component as shown in Fig. 13. The amplitude of the 455KHz frequency component is directly proportional to the amplitude of the 3.545MHz carrier radio frequency. The band pass filter as described next selectively passes only the 455KHz frequency so in effect the circuitry has selectivity for the frequency of 3.545MHz. This helps in the rejection of broad spectrum noise which could potentially interfere with the operation of the device. This technique is known as a superheterodyne receiver. This gives Signal C as shown in Fig. 13. Signal C is then passed through a selective band pass filter 35 tuned at the intermediate frequency. In the preferred embodiment, the selective band pass filter 35 is comprised of a ceramic resonator labelled X2 in Fig. 10. The output of the selective band pass filter 35 is signal D as shown in Fig. 14. Signal D is present in the electronic monitoring circuit only when the tip 8 of the plectrum 4 is in contact with the string 10. This is shown in Fig. 15 where intermittent bursts of signal D are shown.

The signal is then amplified by Q4 as shown in Fig. 10. The degree of amplification is varied by potentiometer VR2. This allows the user to adjust the signal strength, which affects the sensitivity of the system to outside interference. If the gain is too low the system may miss triggers, however if it is too high false triggers may be caused by outside electromagnetic interference.

The signal is then passed through a detector circuit 36 which is made up of Q5, R50 & C42 as also shown in Fig. 10. The output of Q5 is the envelope of the intermediate frequency component which is proportional to the radio frequency signal. This is shown as signal E in Fig. 15. The envelope has brief pulses 37 which substantially correspond to the period of time for which the plectrum tip 8 is in contact with the string 10. This signal is then AC coupled and amplified by U5B as shown in Fig. 10. The brief pulses 37 are then time-stretched so as to provide a modified signal (signal F shown in Fig. 15) having time-stretched pulses 38 which, because of their longer duration, are not missed by the microprocessor to which the signal is subsequently fed. The time-stretching of the pulses 37 is performed by D15, C45, R54 and R57 as shown in Fig. 10.

The electronic monitoring circuitry 12 includes a microprocessor 39 adapted to receive said modified signal (signal F) and to perform an analogue-to-digital conversion thereto using U2 so as to produce a digital representation of signal F. The microprocessor 39 is further adapted to detect positive transients 40 in the digital version of the signal and to generate a triggering signal (signal G) by correlating each of the positive transients 40 with an initial contact of the plectrum tip 8 with the string 10. In other words, each time the plectrum tip 8 initially makes conductive contact with the string 10, instantaneously before the moment of plucking, the electronic monitoring circuitry is adapted to output a triggering signal responsive to said contact. The triggering signal (signal G) provided by one preferred embodiment of the invention is of the MIDI (Musical Instrument Digital Interface) type. An alternative embodiment outputs a triggering signal consisting of a control voltage and a gate signal (this alternative triggering signal is not illustrated). The triggering signal is fed from the receiver 24 via triggering cable 41 as shown in Fig. 8.

Put simply, when a transient 40 of sufficient amplitude is detected, a pick event is deemed to have happened and the associated controlled signals are then generated to provide a triggering signal.

The audio signal (not illustrated) generated by the instrument 11 is applied to amplifier U3C via resistor R13 as shown in Fig. 10. This circuitry 50 is adapted to store maximum amplitudes of the audio signal from the instrument 11. In other words, each time a string 10 of the instrument 11 is plucked, the receiver circuitry stores a maximum amplitude of the resulting audio signal. The circuitry of U3B, U3D, D4, D7 and C15 (as indicated on Fig. 10) holds said maximum amplitude. The electronic monitoring circuitry 12 includes a microprocessor 39 (which may be the same microprocessor mentioned previously, or may be a separate microprocessor) which is adapted to measure the stored amplitude and to output a value corresponding to the amplitude. In some embodiments this value is digital and in other embodiments it is analogue. The value is effectively an output corresponding to the force with which the string 10 is plucked. This information can be transmitted to an audio effects system so that effects can respond to the intensity with which a string 10 is plucked. In some embodiments, the electronic monitoring circuitry 12 and the receiver circuitry 50 are adapted to measure and record the maximum amplitude of the audio signal each time the tip 8 contacts a string 10. In other embodiments, circuitry 12 and 50 is adapted to measure the maximum amplitudes occurring during predefined time intervals.

With reference to Fig. 17, the signal processing apparatus 42 processes the audio signal derived from the string instrument 11. In some preferred embodiments all signal processing is performed digitally, in other preferred embodiments the signal processing may be exclusively analogue, or a combination of digital and analogue. The signal processing apparatus 42 is adapted to function in conjunction with the plectrum of the present invention. The apparatus 42 includes a first input 43 to receive the audio

signal from the string instrument 11. The second input 44 receives the triggering signal (signal G) which includes a plurality of triggering pulses, each indicative of a plucking of any of the strings 10 by the plectrum tip 8. The apparatus 42 houses signal processing circuitry 45 which is adapted to perform a plurality of different processes, each process modifying the audio signal. For example, some of the processes may be relatively straight forward modifications to provide effects such as echo, reverberation, phasing, panning, chorus and flanging. However more sophisticated and elaborate processes may be provided by altering one more parameter values and/or one or more effects algorithms which are, in turn, used by the signal processing circuitry 45 to modify the audio signal. The signal processing circuitry 45 is electrically connected via wires 46 to the first and second inputs respectively, 43 and 44. The signal processing circuitry 45 is adapted to vary the particular process used to modify the audio signal according to a predefined relationship with the triggering signal. In other words, the signal processing circuitry 45 has a number of different processes or "effects", which can be varied based upon the triggering signal. The apparatus 42 also includes an output 47 electrically connected to the digital signal processing circuitry 45 via wire 46 for outputting the modified audio signal (not illustrated).

The predefined relationship between the triggering signal and the varying of the particular process used to modify the audio signal can be adjusted as required. For example, in one embodiment, the particular process used to modify the audio signal is varied each time an integral number of triggering pulses are received. In another embodiment, the integral number is 1, meaning that the particular process used to modify the audio signal is varied each time a triggering pulse is received by the signal processing circuitry 45. This is shown schematically in figure 16. It would be appreciated by those skilled in the art, however, that other predefined relationships may be used, for example making a first variation to the particular process after a first number of triggering pulses

are received, followed by a second variation to the particular process after a second number of triggering pulses are received, and so on.

During the transition from a first process to a second process, the first process is progressively faded out and the second process is simultaneously progressively faded in. This transitional arrangement is illustrated in Fig. 16 where the horizontal axis represents time and the vertical axis represents the degree to which a particular process is used to modify the audio signal. At the time when a triggering pulse is received 48, the degree to which the first process 49 is applied to the audio signal begins to decrease and, simultaneously, the degree to which the second process 50 is applied to the audio signal is increased. This provides a smooth transition between processes. As can be seen in Fig. 16, the same fade-in, fade-out technique is used each time a subsequent variation of a process is made. The transition commences upon receipt of a triggering pulse such that each transition is initiated substantially at each moment the tip 8 first contacts the plectrum during plucking. As described above, triggering from the moment of initial contact (rather than the moment of which contact is broken as in the prior art) advantageously provides a brief lead-in time before the string 10 of the instrument 11 is actually plucked. This enables any delay that may be introduced by the signal processing circuitry 45 to be off-set against the "head start" provided by the triggering signal.

The preferred embodiment of the signal processing apparatus 42 includes provision for at least one of the operative characteristics of one or more of said processes to be variable dependent upon the maximum amplitude of the audio signal each time the plectrum 4 contacts a string 10. The signal processing apparatus 42 includes a third input 51 to receive a value indicative of a maximum amplitude of the audio signal from the microprocessor 39. The third input 51 is adapted to feed the value to the signal processing circuitry 35 via a wire 52. The operative characteristics of the processes which may be varied include factors such as the parameters and/or the algorithms used

to modify the audio signal. In some embodiments, the function of the second and third inputs, 44 and 51, is performed by a single input (not illustrated) which is adapted to receive and de-code an information stream having information relating to both the triggering and the maximum amplitude.

Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

CLAIMS:

1. A plectrum for a string instrument having a plurality of conductive strings, said plectrum including:

a non-conductive body defining a gripping portion and a plucking portion; and

a conductive tip protruding just beyond an edge of said plucking portion, an outer surface of said tip being sized so as to fleetingly contact a string of said instrument when said string is plucked by said plucking portion, said tip further being capable of operative association with electronic monitoring circuitry adapted to provide a triggering signal each time the tip contacts any one of said strings.

2. A plectrum according to claim 1 wherein said tip is electrically connected to a first wire embedded within said body, said first wire being, in turn, electrically connected to a second wire external of said body and extending from a point on said body remote of said plucking portion.

3. A plectrum according to claim 1 or 2 wherein said tip protrudes from an outer edge of said plucking portion by no more than 1 mm.

4. A plectrum according to any one of the preceding claims wherein a perimeter length of said tip is no longer than 8 mm.

5. A plectrum according to any one of the preceding claims wherein a width of said tip is less than a width of said body.

6. A plectrum according to any one of the preceding claims wherein said body is generally a triangular shape, a region adjacent a first apex of said triangular shape defining said plucking portion, and a region adjacent the other two apexes defining said gripping portion, said tip being disposed at said first apex.

7. A plectrum according to claim 6 when depended from claim 2, wherein said second wire extends from, or adjacent to, one of said other apexes.

8. A plectrum according to any one of the preceding claims wherein an outer edge of said tip is shaped to generally correspond to a shape of said outer edge of said plucking region from which it extends.

9. A plectrum according to any of the preceding claims wherein said electronic monitoring circuitry is adapted to detect the initial contact between the tip and the string and to use said initial contact as the basis for the triggering signal.

10. A transmitter / receiver arrangement adapted for use with a plectrum as defined in any one of claims 1 to 9, said arrangement including a transmitter having a signal generator electrically connectable to said tip such that, when said tip fleetingly connects with said string during plucking, the transmitter produces a signal which is detectable by receiver circuitry, said receiver circuitry being operatively associated with said electronic monitoring circuitry so as to provide said triggering signal.

11. A transmitter / receiver arrangement according to claim 10 wherein said transmitter is mountable to a person playing the instrument, said transmitter being electrically connectable to said plectrum by said second wire.

12. A transmitter / receiver arrangement according to claim 11 wherein said transmitter is disposed upon, or housed within, a strap mountable to a wrist of said person.

13. A transmitter / receiver arrangement according to claim 12 wherein said strap includes means to house or mount a battery to power said radio frequency signal generator.

14. A transmitter / receiver arrangement according to any one of claims 10 to 13 wherein said string is electrically connected to an instrument-ground, which is, in turn, electrically connected to said receiver.

15. A transmitter / receiver arrangement according to any one of claims 10 to 14 wherein said signal generator is a radio frequency signal generator capable of producing a waveform at a carrier frequency, and said receiver circuitry is adapted to compare the carrier frequency with a local oscillator signal so as to only acknowledge a contact between the tip and the string once an intermediate frequency, which is a difference between the carrier frequency and the local oscillator frequency, is detected by the receiver, thereby reducing the likelihood of false triggering due to outside interference from radio frequency noise.

16. A transmitter / receiver arrangement according to claim 15 wherein both said carrier frequency and a frequency of said local oscillator signal are within the range 100 Khz to 30 MHz.

17. A transmitter / receiver arrangement according to claim 15 or 16 wherein said instrument-ground is electrically connected to a receiver-ground, said connection effectively forming an electrical short between said grounds at audio frequencies, and a first tuned receiver between said grounds which is broadly tuned at said carrier frequency.

18. A transmitter / receiver arrangement according to claim 16 wherein said connection is an inductor and a capacitor wired in parallel between the instrument-ground and the receiver-ground.

19. A transmitter / receiver arrangement according to claim 17 or 18 wherein, after passing through said connection, the radio frequency signal is amplified.

20. A transmitter / receiver arrangement according to any one of claims 17 to 19 wherein said receiver circuitry includes a selective band pass filter tuned at the intermediate frequency.

21. A transmitter / receiver arrangement according to claim 19 or 20 wherein said local oscillator signal is derived from a clock circuit of a microprocessor or from a frequency crystal.

22. A transmitter / receiver arrangement according to any one of claims 10 to 21 wherein said electronic monitoring circuitry includes a detector circuit adapted to output an envelope of the intermediate frequency component of the radio frequency signal, said envelope having brief pulses substantially corresponding to the period of time for which the plectrum tip is in contact with the string.

23. A transmitter / receiver arrangement according to claim 22 wherein said brief pulses are time-stretched so as to provide a modified signal having time-stretched pulses which would not be missed by a microprocessor.

24. A transmitter / receiver arrangement according to claim 23 wherein said electronic monitoring circuitry includes a microprocessor adapted to receive said modified signal and perform an analog-to-digital conversion thereto.

25. A transmitter / receiver arrangement according to claim 24 wherein said microprocessor is further adapted to detect positive transients in said modified signal and to generate said triggering signal by correlating each of said positive transients with an initial contact of the plectrum tip with the string.

26. A transmitter / receiver arrangement according to any one of claims 10 to 25 wherein said receiver circuitry is adapted to store and output a value corresponding to a maximum amplitude of an audio signal from said instrument each time the plectrum contacts the string.

27. A transmitter / receiver arrangement according to claim 26 wherein said electronic monitoring circuitry includes a microprocessor adapted to measure the stored value and to output a digital value corresponding to the amplitude.

28. A transmitter adapted for use with a plectrum as defined in any one of claims 1 to 9, said transmitter having a radio frequency signal generator electrically connectable to said tip such that, when said tip fleetingly connects with said string during plucking, the tip injects a radio frequency signal into the string.

29. A receiver adapted for use with the transmitter as defined in claim 28 including receiver circuitry being tuned to said radio frequency so as to detect the radio frequency signal injected into the string, the receiver being operatively associated with said electronic monitoring circuitry so as to provide said triggering signal.

30. A signal processing apparatus adapted to process an audio signal derived from a string instrument having a plurality of conductive strings being plucked by the plectrum defined in any one of claims 1 to 9, said apparatus including:

a first input to receive said audio signal;

a second input to receive a triggering signal which includes a plurality of triggering pulses, each indicative of a plucking of any of said strings by said plectrum tip;

signal processing circuitry adapted to perform a plurality of different processes, each process modifying the audio signal, said circuitry being electrically connected to said first and second inputs, and wherein said signal processing circuitry is adapted to vary the particular process used to modify the audio signal according to a predefined relationship with said triggering signal; and

an output electrically connected to said signal processing circuitry for outputting a modified audio signal.

31. A signal processing apparatus according to claim 30 wherein said predefined relationship is such that the process is varied each time an integral number of triggering pulses are received by the signal processing circuitry.

32. A signal processing apparatus according to claim 31 wherein said integral number is one.

33. A signal processing apparatus according to any one of claims 30 to 32 wherein, during a transition from a first process to a second process, the first process is progressively faded out and the second process is simultaneously progressively faded in.

34. A signal processing apparatus according to claim 33 wherein said transition commences upon receipt of a triggering pulse such that each transition is initiated substantially at each moment the tip first contacts the plectrum during plucking.

35. A signal processing apparatus according to any one of claims 30 to 34 wherein at least one of the operative characteristics of one or more of said processes is variable

dependent upon a maximum amplitude of the audio signal each time the plectrum contacts a string.

36. A signal processing apparatus according to any one of claims 30 to 35 wherein said plectrum communicates with said signal processing apparatus via the transmitter and/or receiver apparatus as defined in any one of claims 10 to 29.

37. A signal processing apparatus according to claim 36 when depended from claim 35 and wherein the transmitter / receiver arrangement is in accordance with claim 27, wherein the signal processing apparatus includes a third input to receive said digital value, said third input being adapted to feed said value to the signal processing circuitry.

38. A signal processing apparatus according to claim 37, wherein the second and third inputs comprise a single input which is adapted to receive and decode an information stream having information relating to both the triggering and the maximum amplitude.

39. A plectrum substantially as herein described with reference to any one embodiment as shown in the accompanying drawings.

40. A transmitter / receiver arrangement substantially as herein described with reference to any one embodiment as shown in the accompanying drawings.

41. A transmitter substantially as herein described with reference to any one embodiment as shown in the accompanying drawings.

42. A receiver substantially as herein described with reference to any one embodiment as shown in the accompanying drawings.

43. A signal processing apparatus substantially as herein described with reference to any one embodiment as shown in the accompanying drawings.

Fig 1

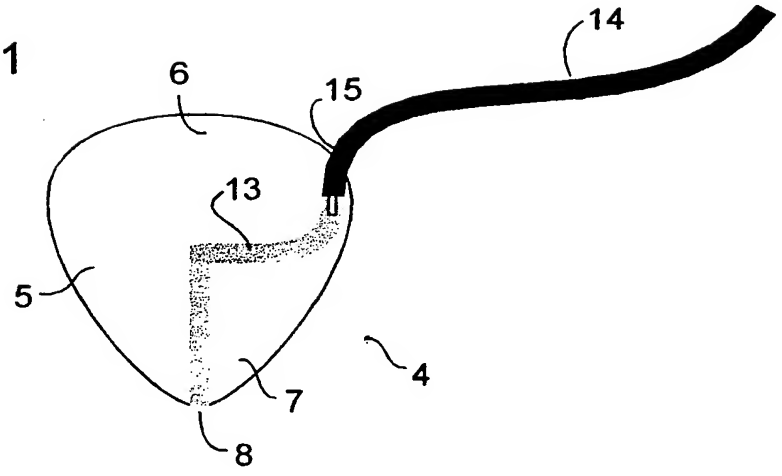
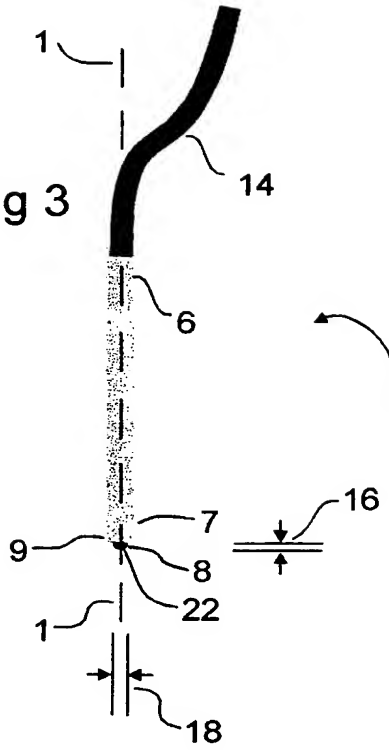


Fig 3



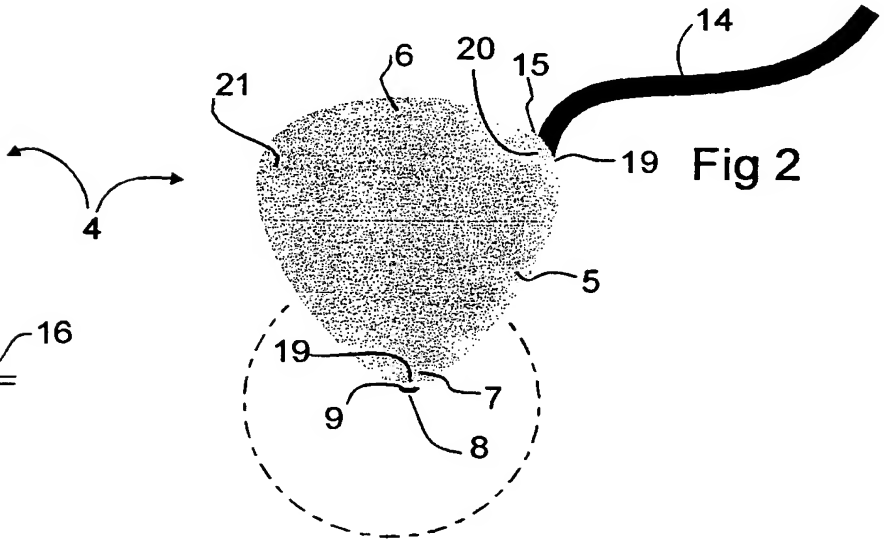


Fig 2

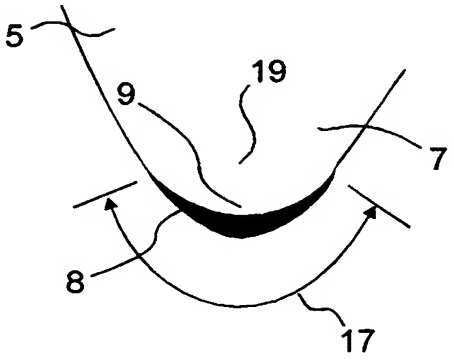


Fig 2A

Fig 4

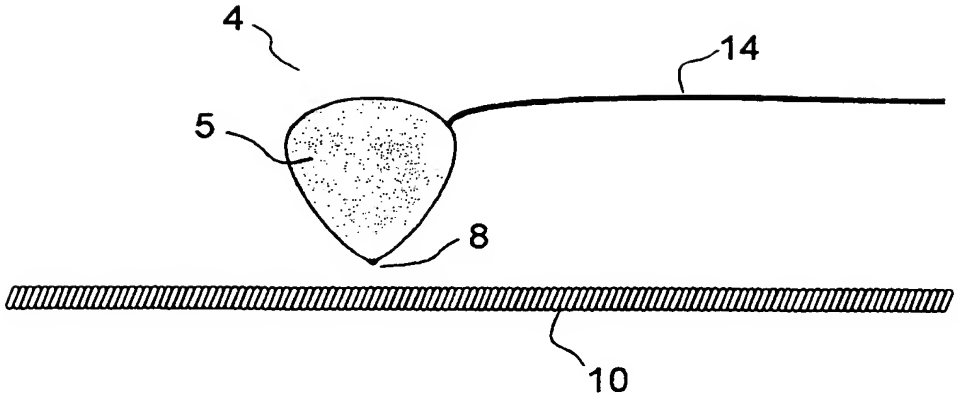
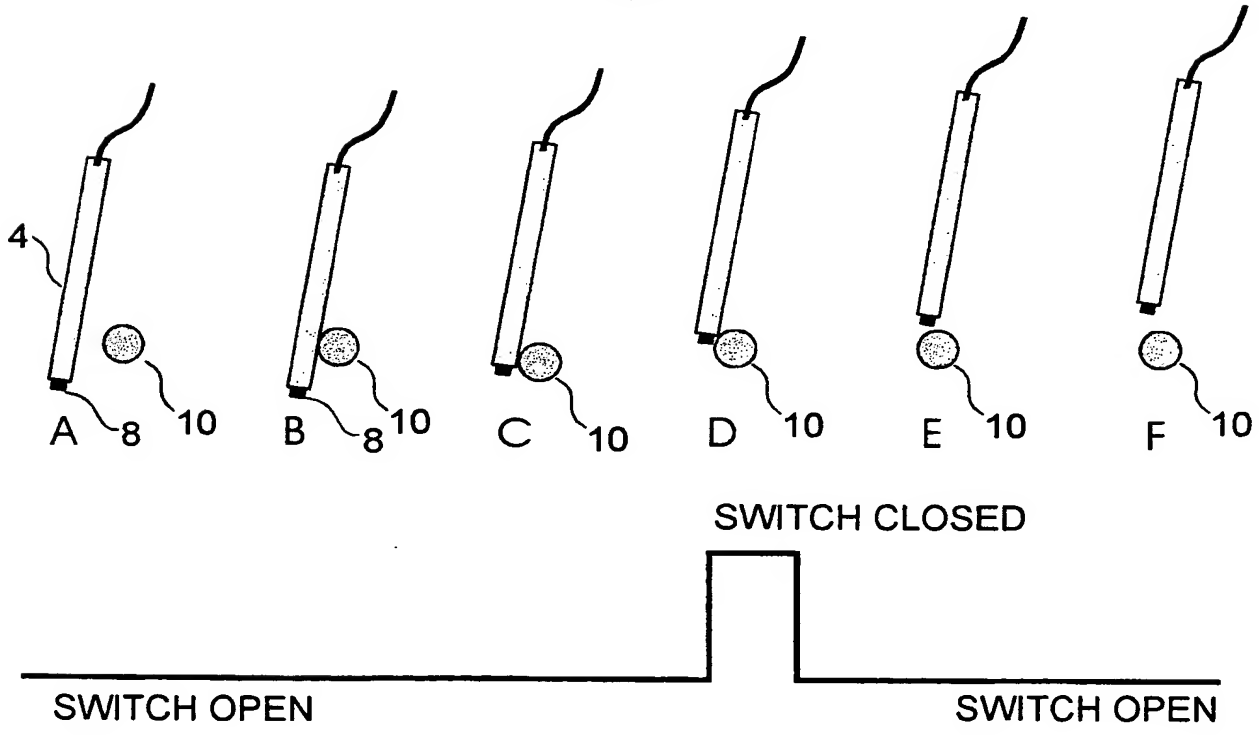

4
14
5
8
10

Fig 5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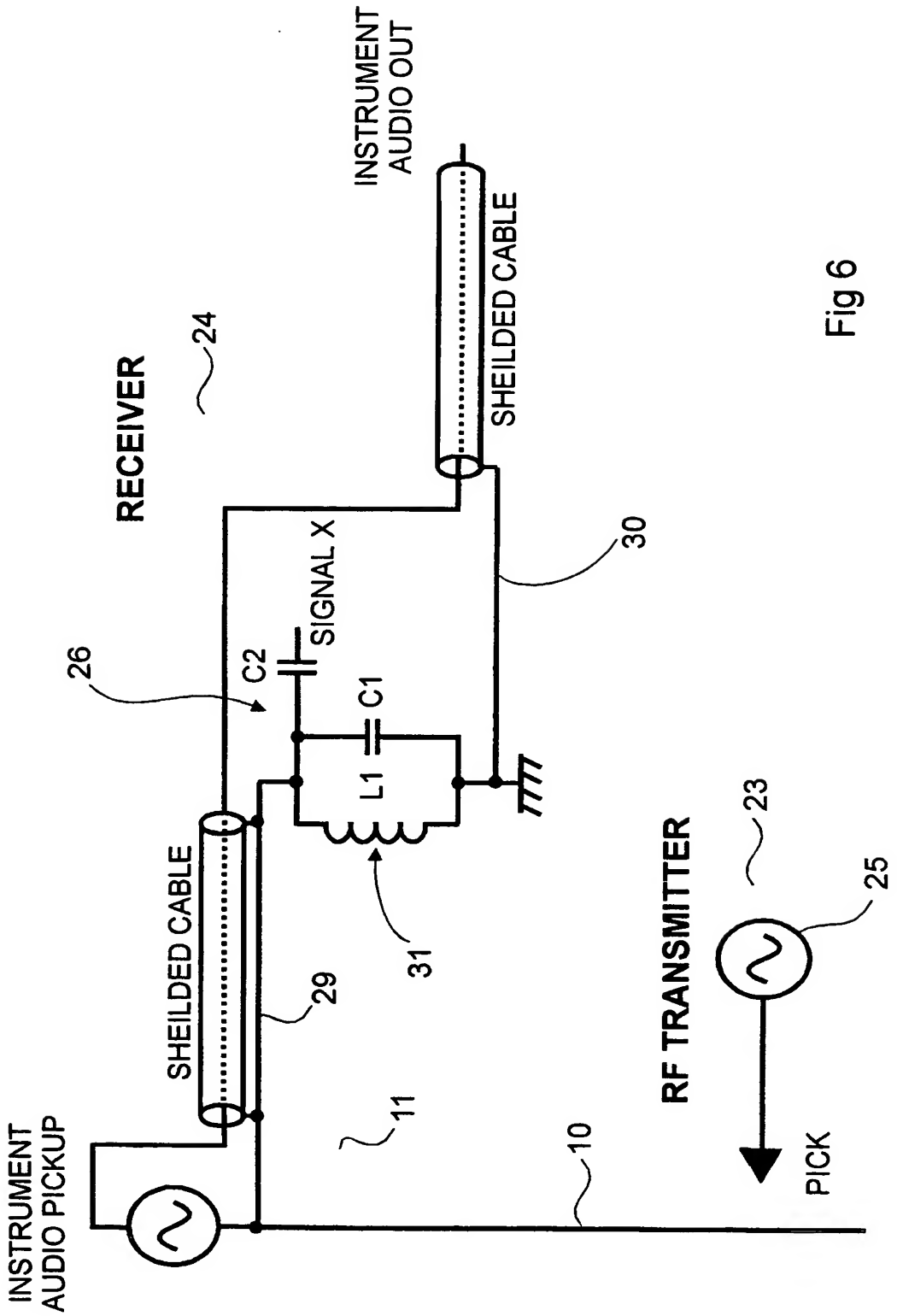

INSTRUMENT AUDIO PICKUP
SHEILDED CABLE
RECEIVER
24
INSTRUMENT AUDIO OUT
SHEILDED CABLE
SIGNAL X
C2
C1
L1
26
29
31
30
11
10
RF TRANSMITTER
23
25
PICK

Fig 6

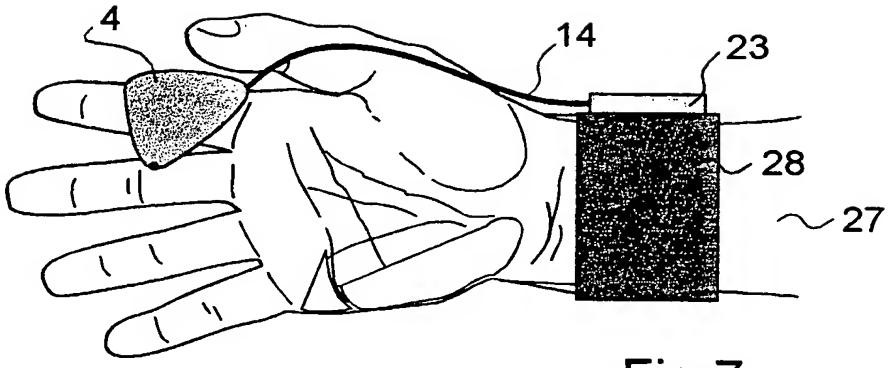


Fig 7

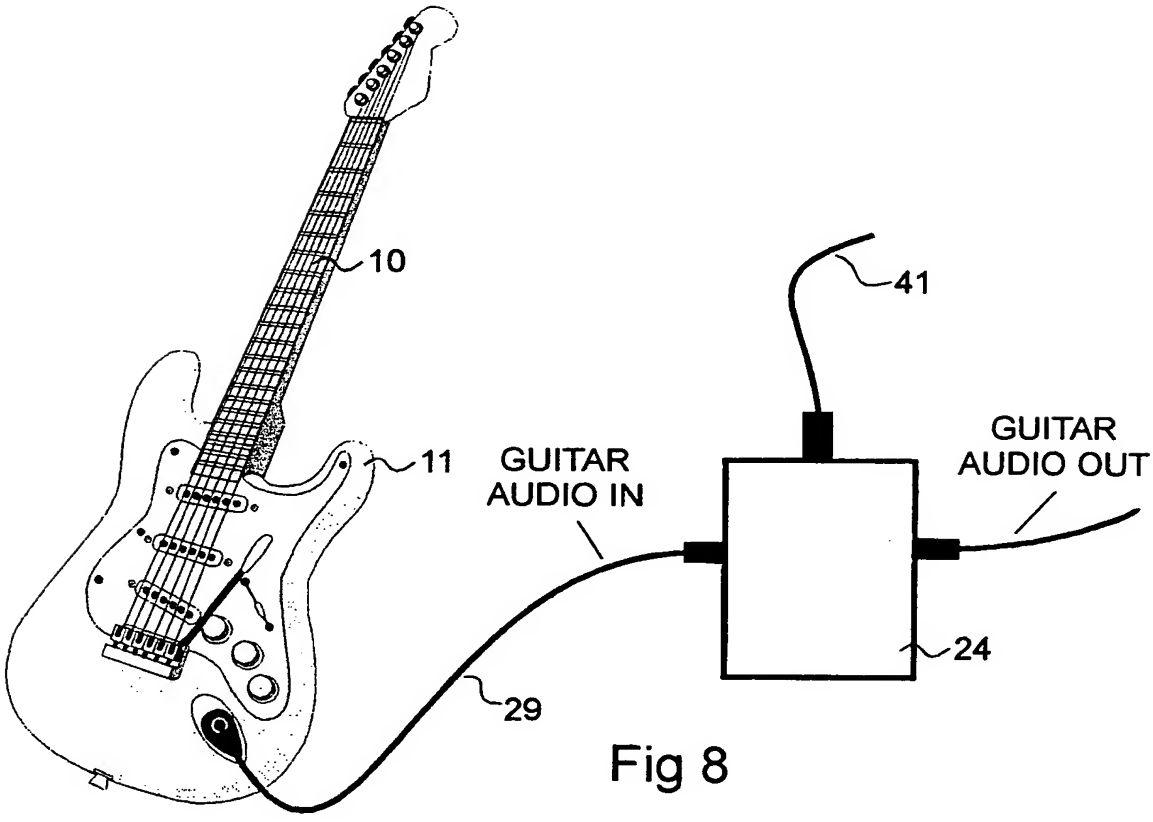


Fig 8

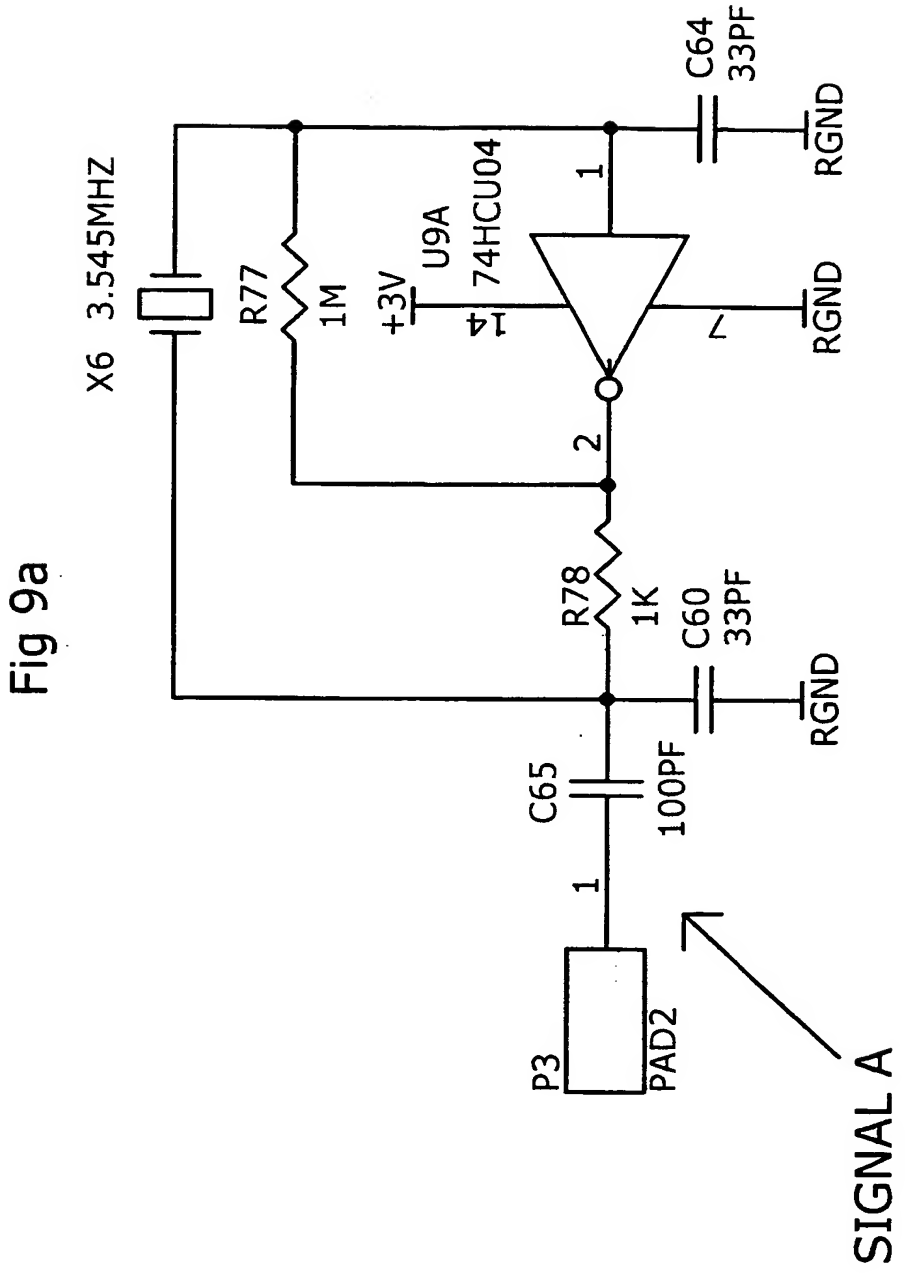

X6 3.545MHZ
R77
1M
+3V
U9A
74HCU04
14
1
7
2
C64
33PF
RGND
RGND
R78
1K
C60
33PF
RGND
C65
100PF
1
P3
PAD2
SIGNAL A

Fig 9a

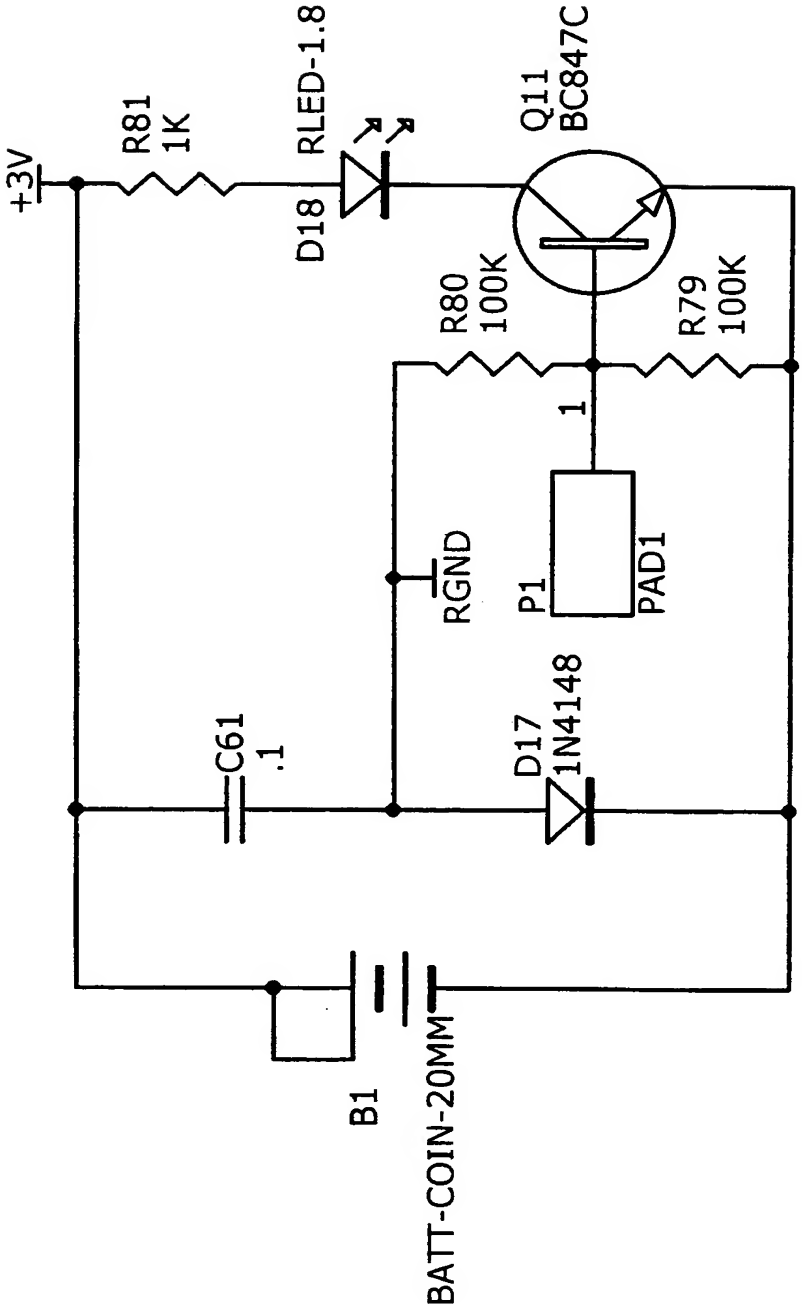

+3V
R81
1K
RLED-1.8
D18
Q11
BC847C
R80
100K
R79
100K
1
RGND
P1
PAD1
C61
.1
D17
1N4148
B1
BATT-COIN-20MM

Fig 9b

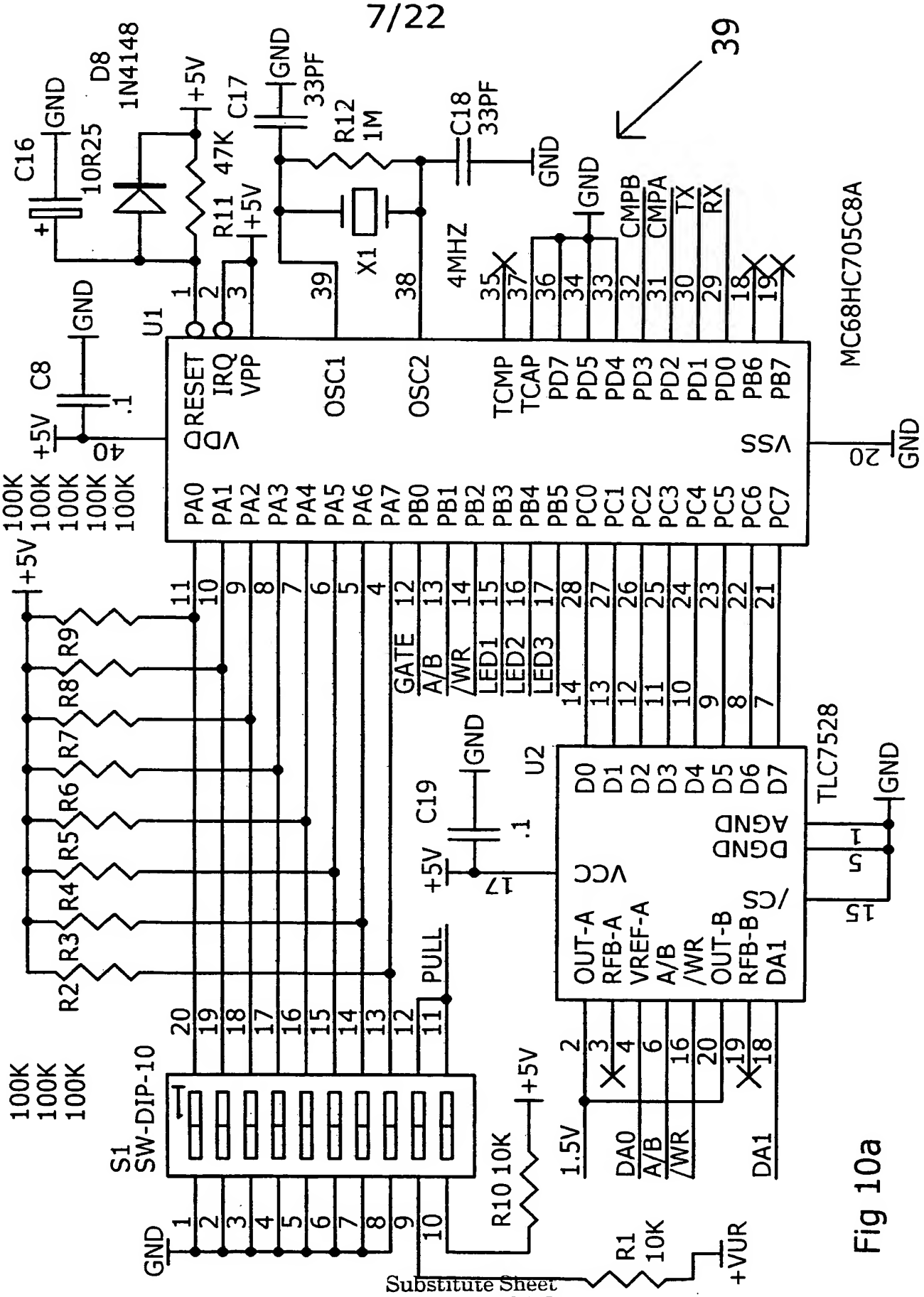

39
MC68HC705C8A
U1
U2
TLC7528
S1
SW-DIP-10
D8
1N4148
C16
10R25
C17
33PF
C18
33PF
C19
C8
R11 47K
R12
1M
X1
4MHZ
R1
10K
R10 10K
R2
R3
R4
R5
R6
R7
R8
R9
100K
+5V
GND
+VUR
1.5V
RESET
IRQ
VPP
OSC1
OSC2
TCMP
TCAP
PD7
PD5
PD4
PD3
PD2
PD1
PD0
PB6
PB7
VSS
VDD
PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PB0
PB1
PB2
PB3
PB4
PB5
PC0
PC1
PC2
PC3
PC4
PC5
PC6
PC7
CMPB
CMPA
TX
RX
GATE
A/B
/WR
LED1
LED2
LED3
PULL
D0
D1
D2
D3
D4
D5
D6
D7
VCC
DGND
AGND
/CS
OUT-A
RFB-A
VREF-A
A/B
/WR
OUT-B
RFB-B
DA1
DA0

Fig 10a

Fig 10b

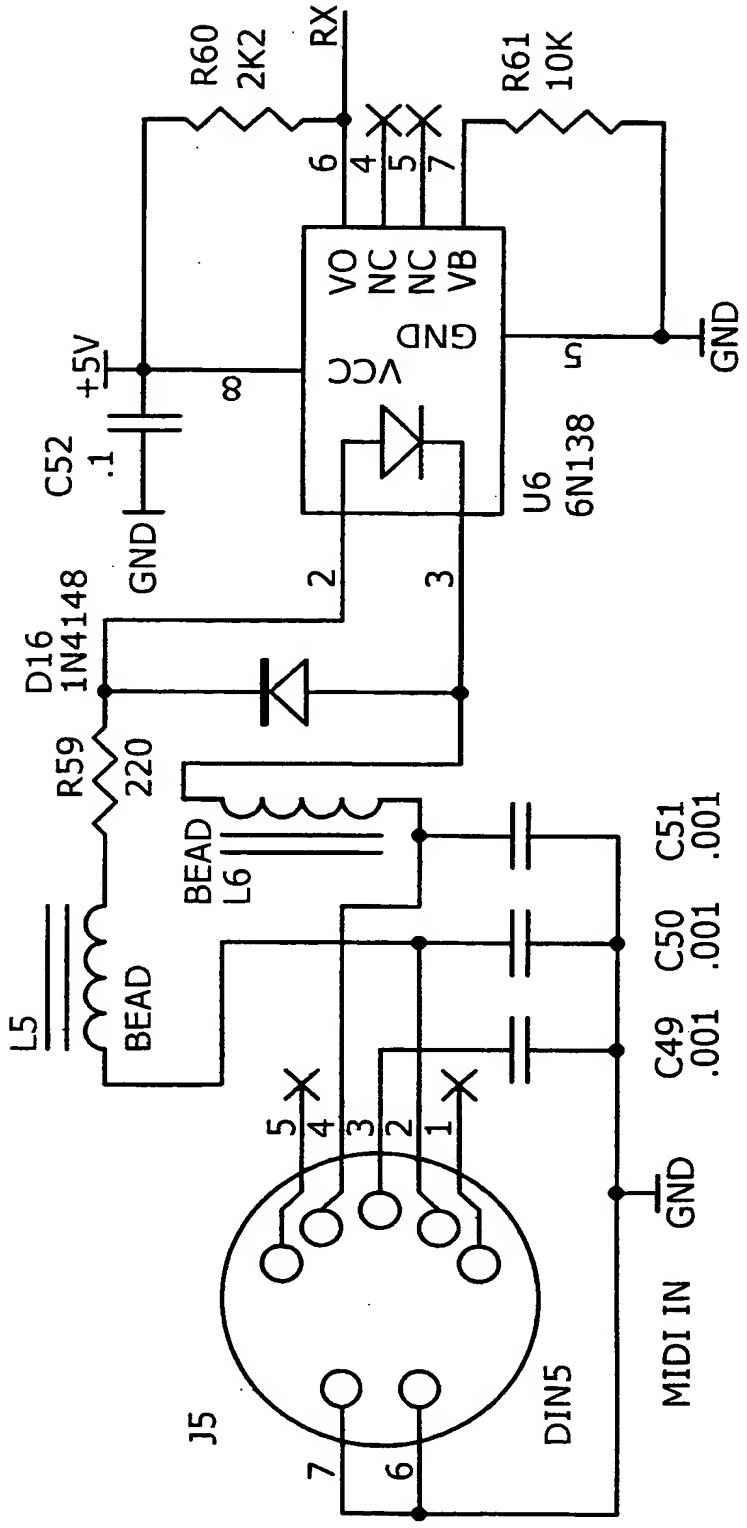

R60
2K2
RX
R61
10K
6
4
5
7
VO
NC
NC
VB
GND
VCC
+5V
8
5
GND
C52
.1
GND
U6
6N138
2
3
D16
1N4148
R59
220
BEAD
L6
C51
.001
C50
.001
C49
.001
L5
BEAD
5
4
3
2
1
GND
J5
DIN5
MIDI IN
7
6

Fig 10c

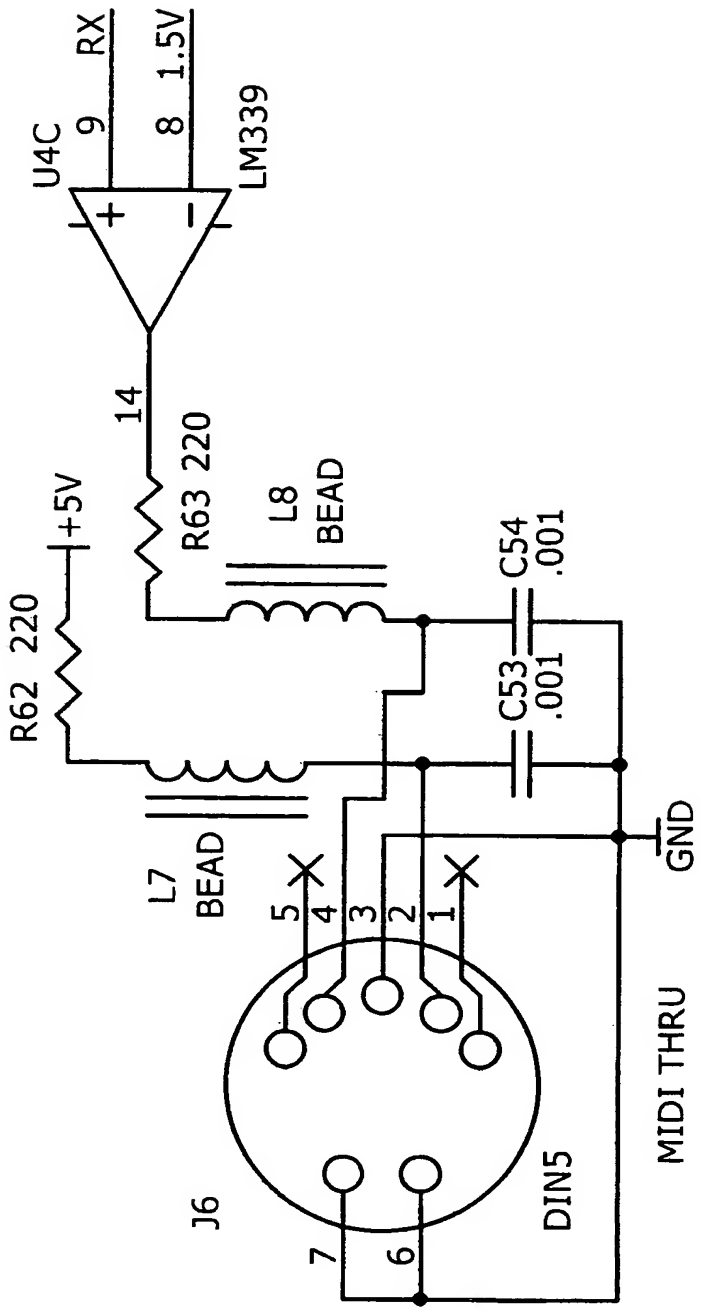

U4C
9
RX
8
1.5V
LM339
+
-
14
+5V
R63 220
L8
BEAD
C54
.001
R62 220
C53
.001
GND
L7
BEAD
5
4
3
2
1
J6
DIN5
7
6
MIDI THRU

Fig 10d

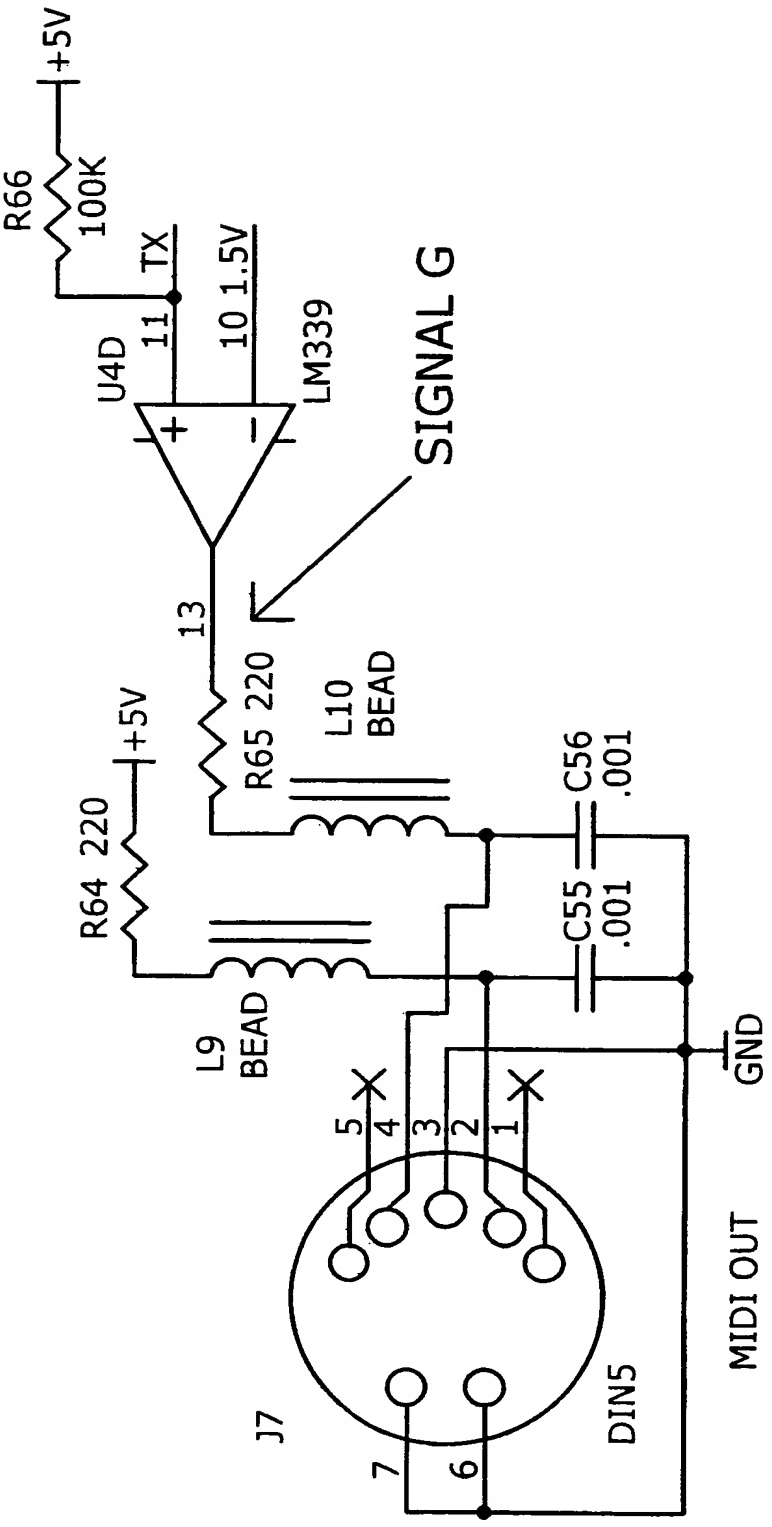

+5V
R66
100K
TX
11
10 1.5V
U4D
LM339
SIGNAL G
13
R65 220
L10
BEAD
+5V
R64 220
L9
BEAD
C56
.001
C55
.001
GND
5
4
3
2
1
J7
DIN5
7
6
MIDI OUT

Fig 10e

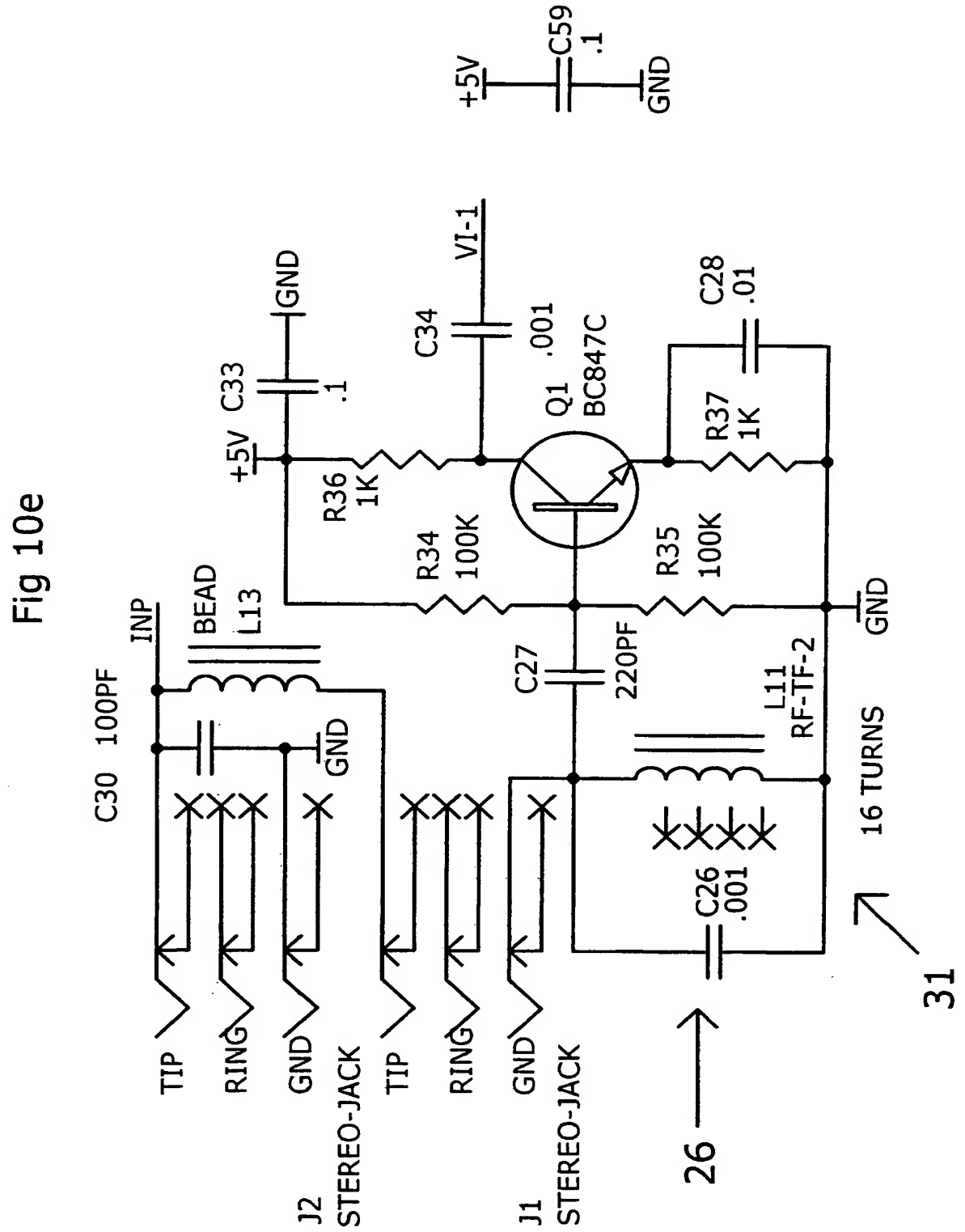
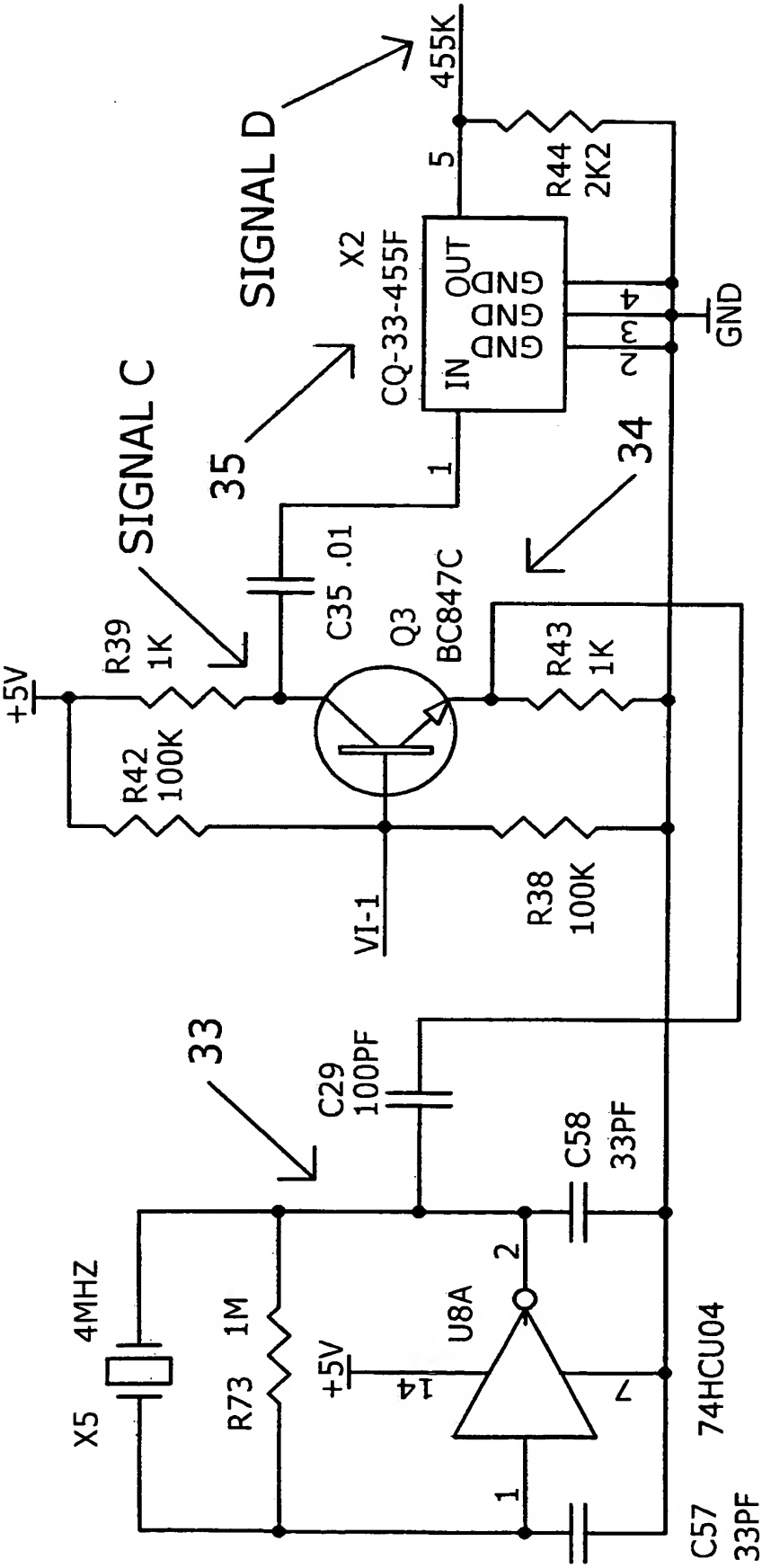

+5V
C59
.1
GND
VI-1
C34
.001
Q1
BC847C
C28
.01
GND
C33
.1
+5V
R36
1K
R37
1K
R34
100K
R35
100K
INP
BEAD
L13
C27
220PF
GND
C30 100PF
GND
L11
RF-TF-2
16 TURNS
C26
.001
TIP
RING
GND
J2
STEREO-JACK
TIP
RING
GND
J1
STEREO-JACK
26
31

Fig 10f


SIGNAL D
455K
5
R44
2K2
X2
CQ-33-455F
OUT
GND
GND
GND
IN
4
2
GND
35
SIGNAL C
1
34
C35 .01
Q3
BC847C
R39
1K
+5V
R43
1K
R42
100K
R38
100K
VI-1
33
C29
100PF
C58
33PF
4MHZ
X5
R73
1M
+5V
14
U8A
2
7
74HCU04
1
C57
33PF

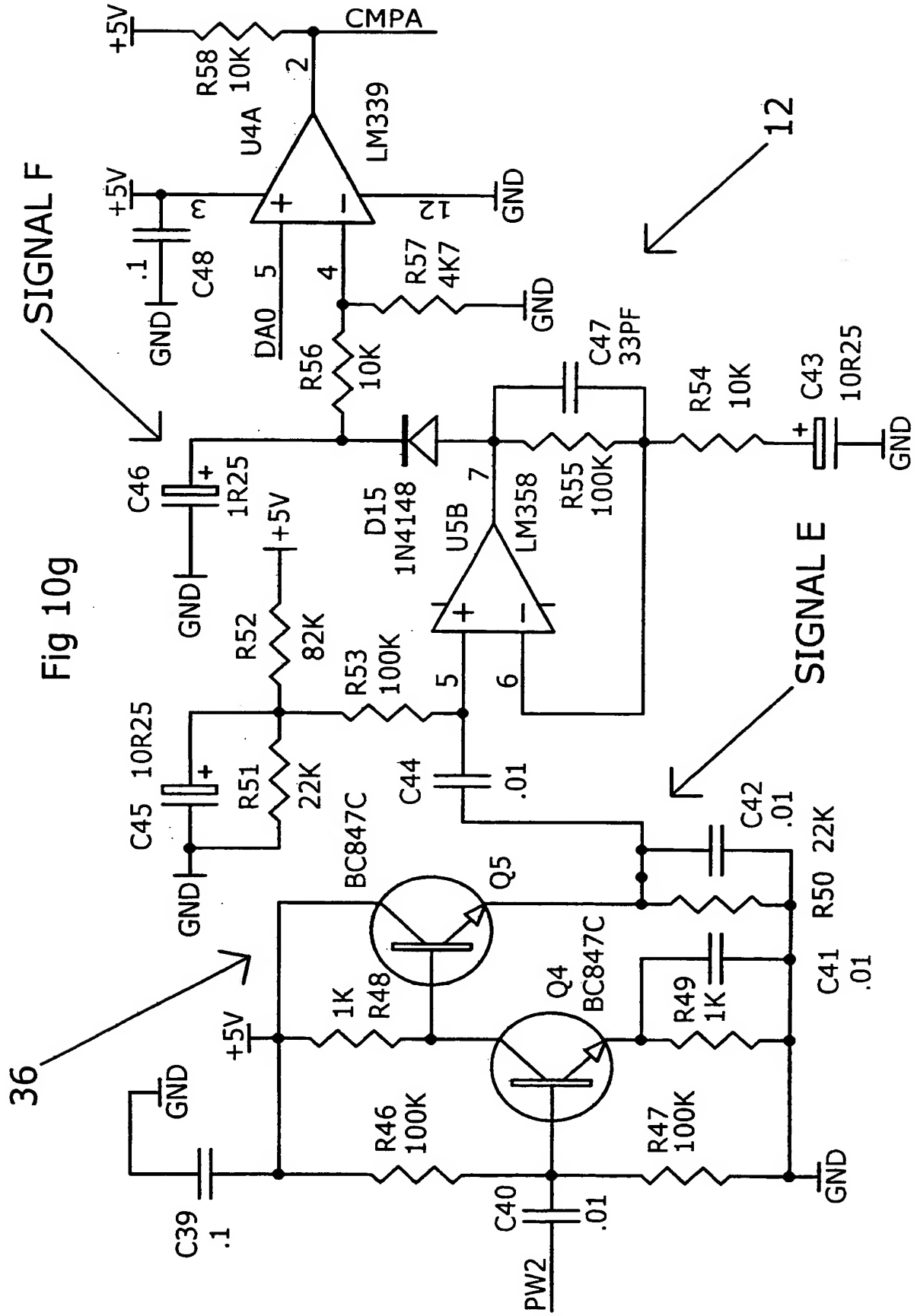
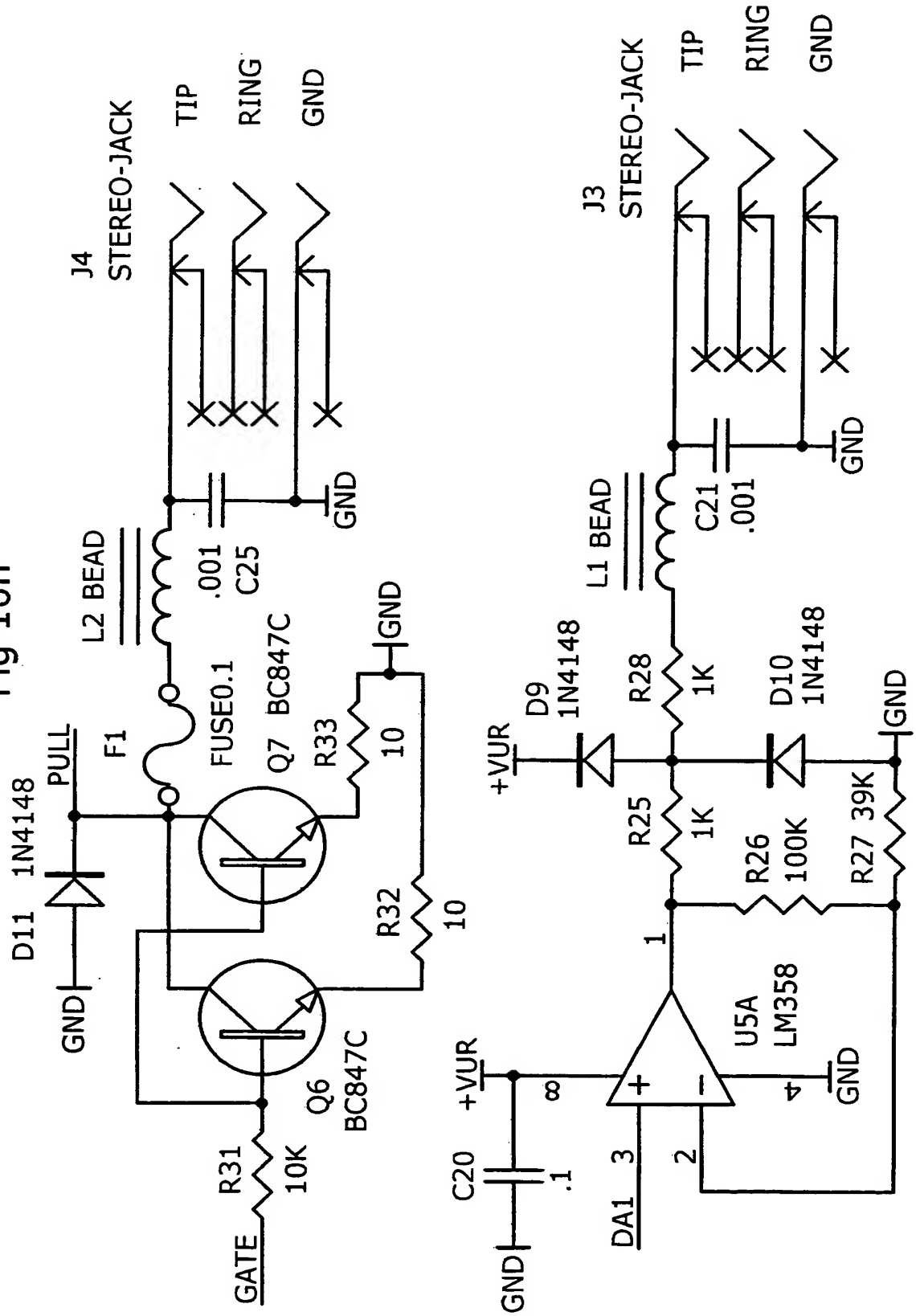

SIGNAL F
SIGNAL E
12
36
+5V
CMPA
R58 10K
U4A
LM339
GND
C48 .1
DA0
R56 10K
R57 4K7
C47 33PF
R54 10K
C43 10R25
C46 1R25
D15 1N4148
U5B
LM358
R55 100K
R52 82K
R53 100K
C45 10R25
R51 22K
C44 .01
C42 .01
R50 22K
BC847C
Q5
Q4
R48 1K
R49 1K
C41 .01
R46 100K
R47 100K
C39 .1
C40 .01
PW2

Fig 10g

Fig 10h


J4
STEREO-JACK
TIP
RING
GND
L2 BEAD
.001
C25
GND
F1
FUSE0.1
Q7 BC847C
R33
10
GND
PULL
D11 1N4148
GND
R32
10
Q6
BC847C
R31
10K
GATE
J3
STEREO-JACK
TIP
RING
GND
L1 BEAD
C21
.001
GND
D9
1N4148
R28
1K
D10
1N4148
GND
+VUR
R25
1K
R26
100K
R27 39K
1
U5A
LM358
8
4
+VUR
C20
.1
GND
DA1
3
2

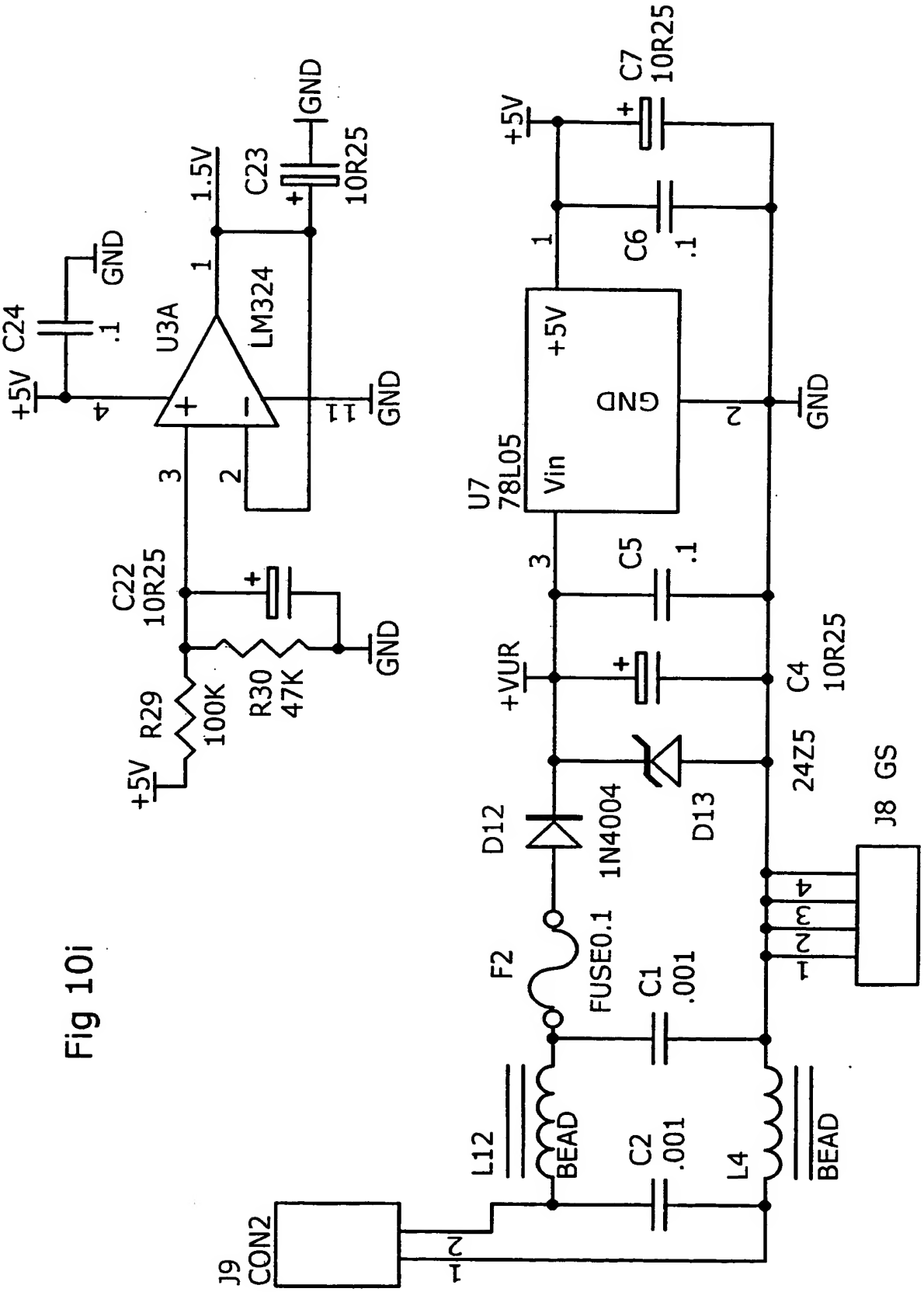

J9
CON2
L12
BEAD
C2
.001
L4
BEAD
F2
FUSE0.1
C1
.001
D12
1N4004
D13
24Z5
J8 GS
+VUR
C4
10R25
U7
78L05
Vin
GND
+5V
C5
.1
C6
.1
C7
10R25
U3A
LM324
1.5V
C23
10R25
C24
.1
C22
10R25
R29
100K
R30
47K
GND

Fig 10i

Fig 10j

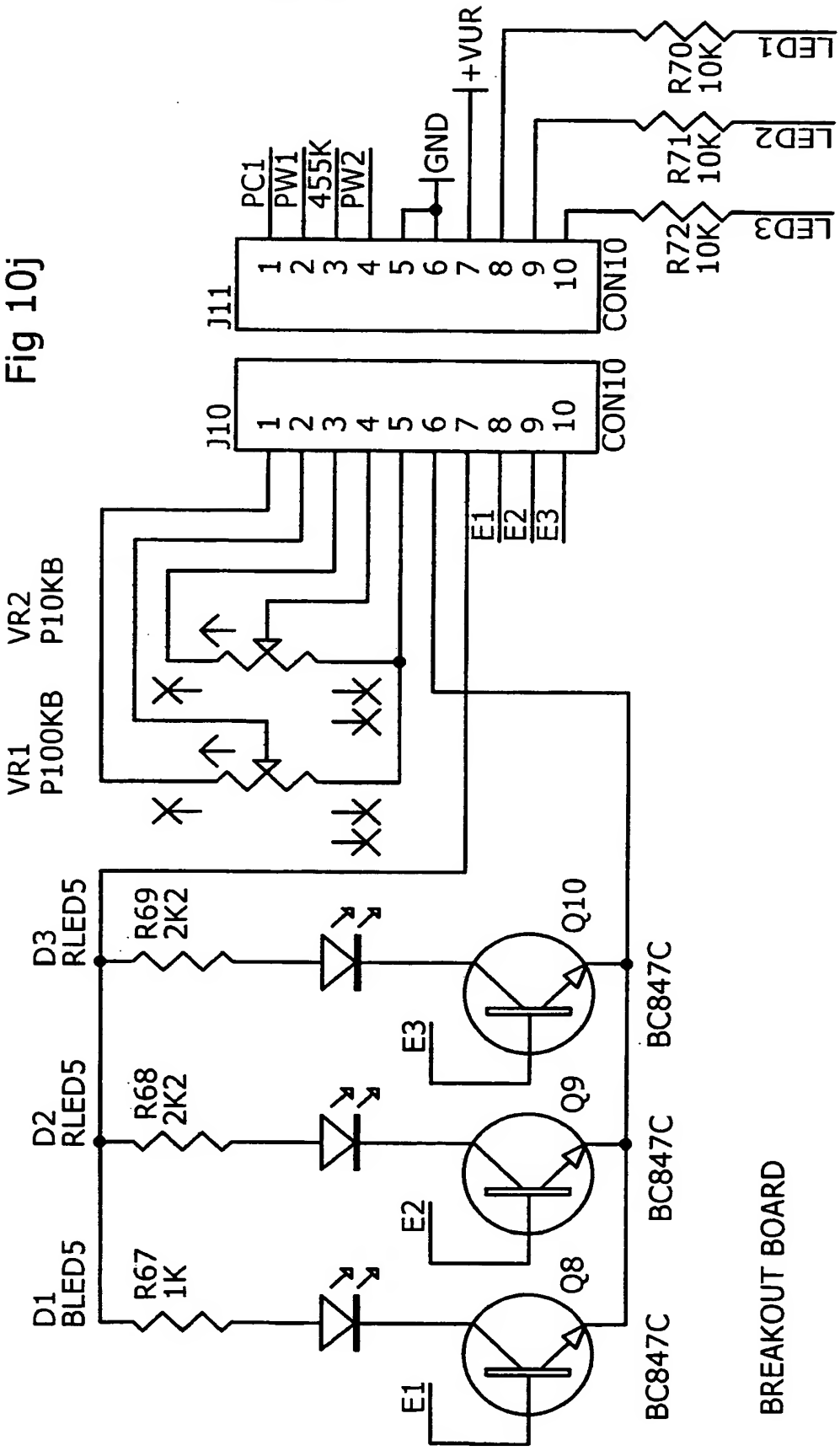

J11
CON10
PC1
PW1
455K
PW2
GND
+VUR
R70 10K
R71 10K
R72 10K
LED1
LED2
LED3
J10
CON10
E1
E2
E3
VR1 P100KB
VR2 P10KB
D3 RLED5
R69 2K2
Q10
BC847C
D2 RLED5
R68 2K2
Q9
BC847C
D1 BLED5
R67 1K
Q8
BC847C
BREAKOUT BOARD

Fig 10k

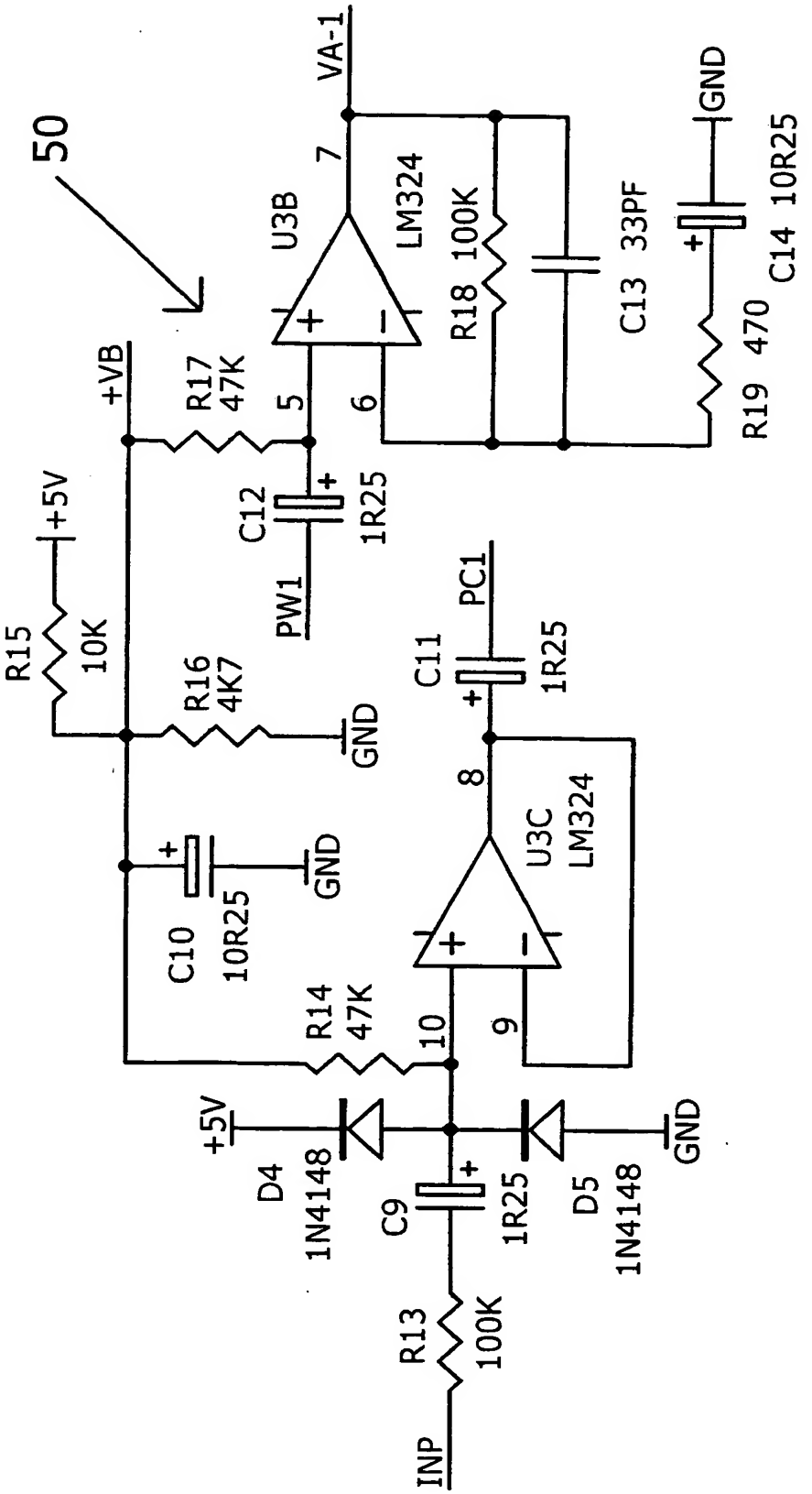

50
VA-1
U3B
LM324
7
6
5
R18 100K
C13 33PF
GND
C14 10R25
R19 470
+VB
R17 47K
C12
1R25
PW1
+5V
R15 10K
R16 4K7
GND
C11
PC1
1R25
8
U3C
LM324
C10 10R25
GND
R14 47K
10
9
+5V
D4 1N4148
C9
1R25
D5 1N4148
GND
R13 100K
INP

Fig 10L

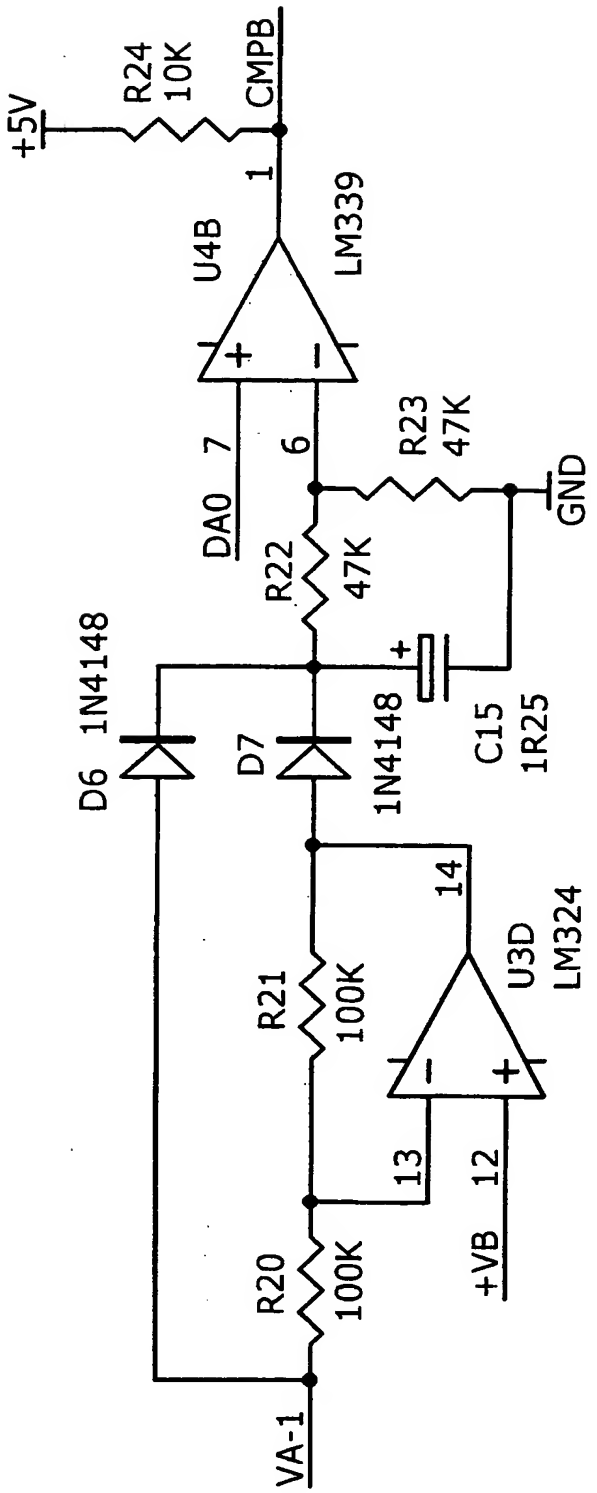

+5V
R24
10K
CMPB
1
U4B
LM339
DA0
7
6
R23
47K
GND
R22
47K
D6 1N4148
D7
1N4148
C15
1R25
14
U3D
LM324
R21
100K
13
12
+VB
R20
100K
VA-1

Fig 11 SIGNAL A

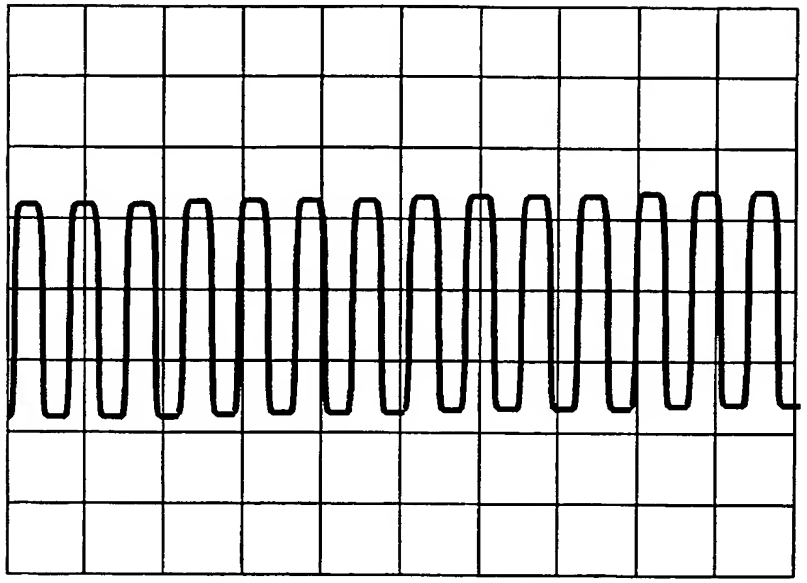


Fig 12 SIGNAL B

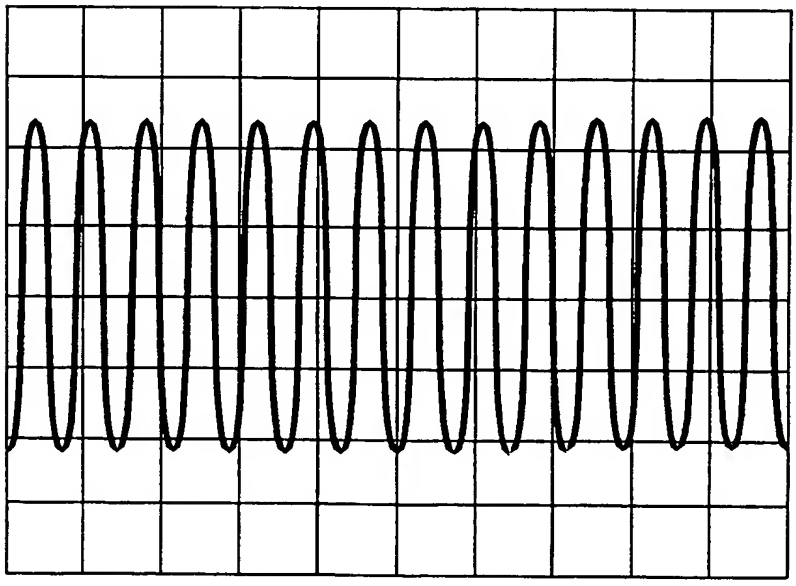


Fig 13 SIGNAL C

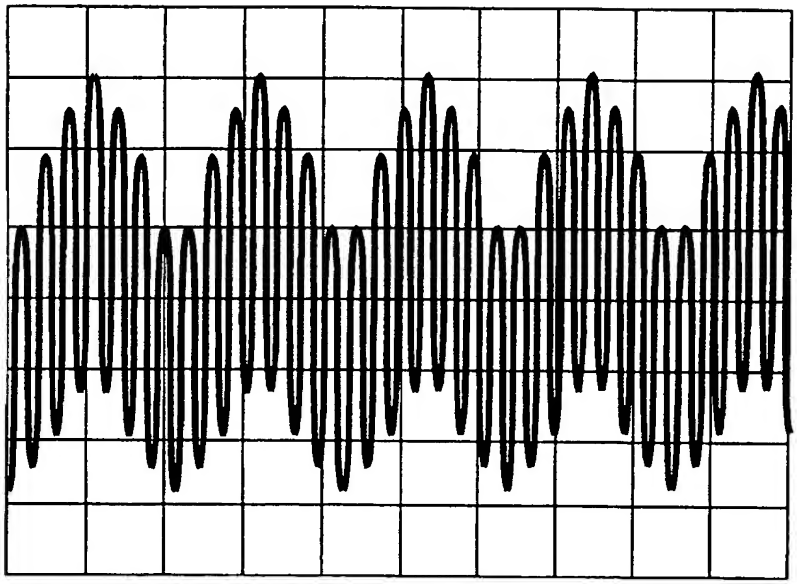
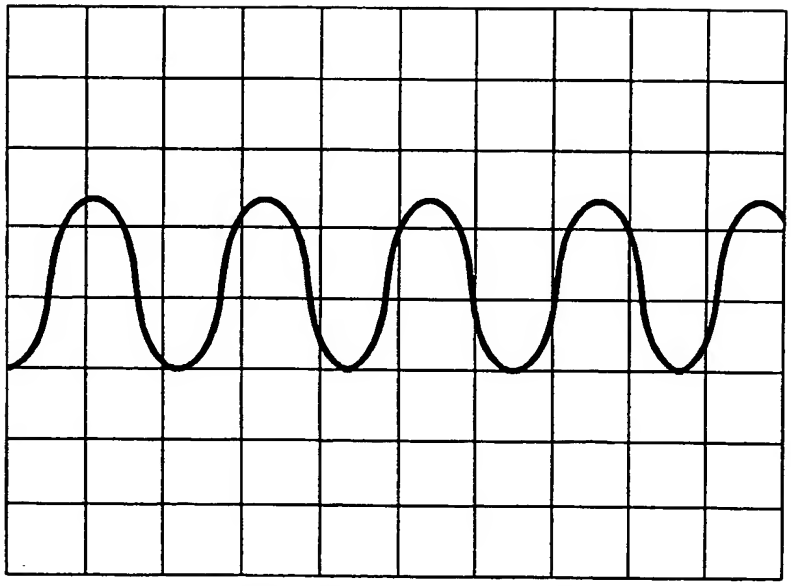


Fig 14 SIGNAL D



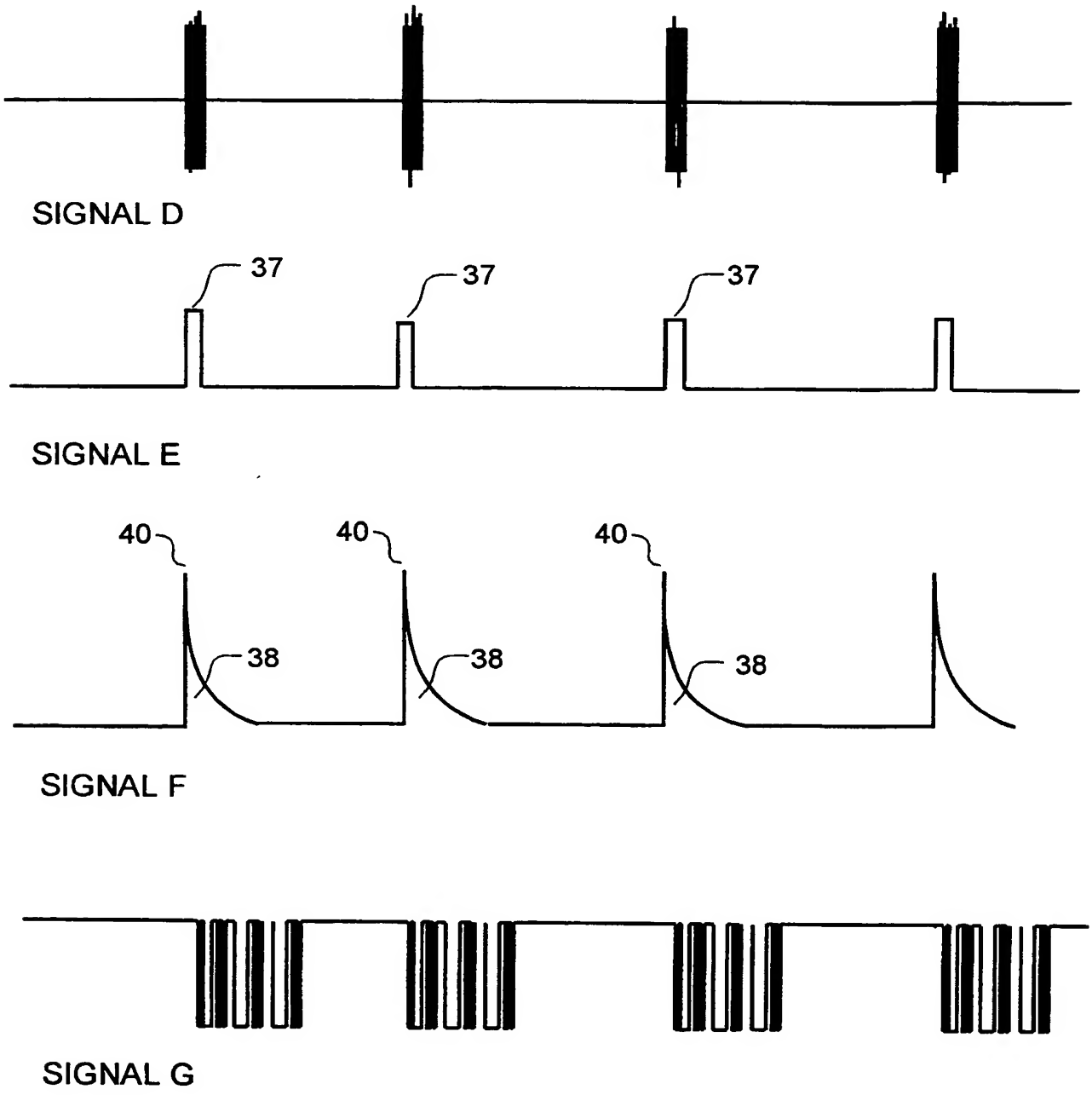


Fig 15

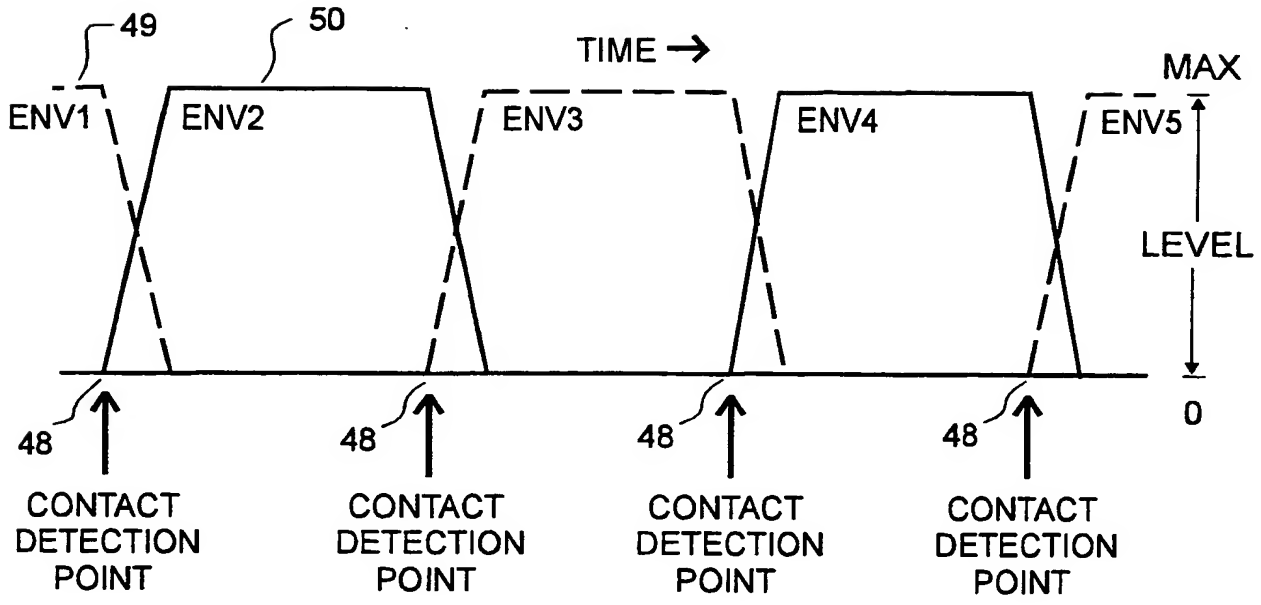

49
50
TIME →
MAX
ENV1
ENV2
ENV3
ENV4
ENV5
LEVEL
0
48
48
48
48
CONTACT DETECTION POINT
CONTACT DETECTION POINT
CONTACT DETECTION POINT
CONTACT DETECTION POINT

FIG 16

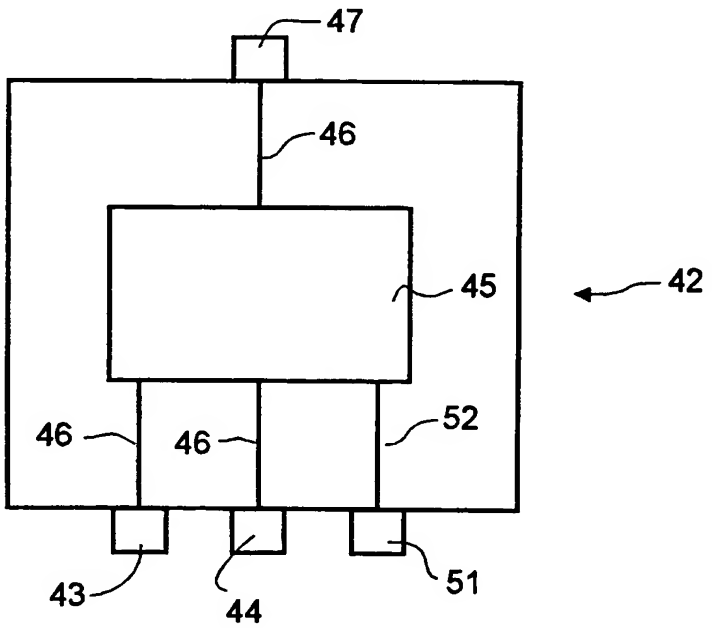

47
46
45
42
46
46
52
43
44
51

FIG 17